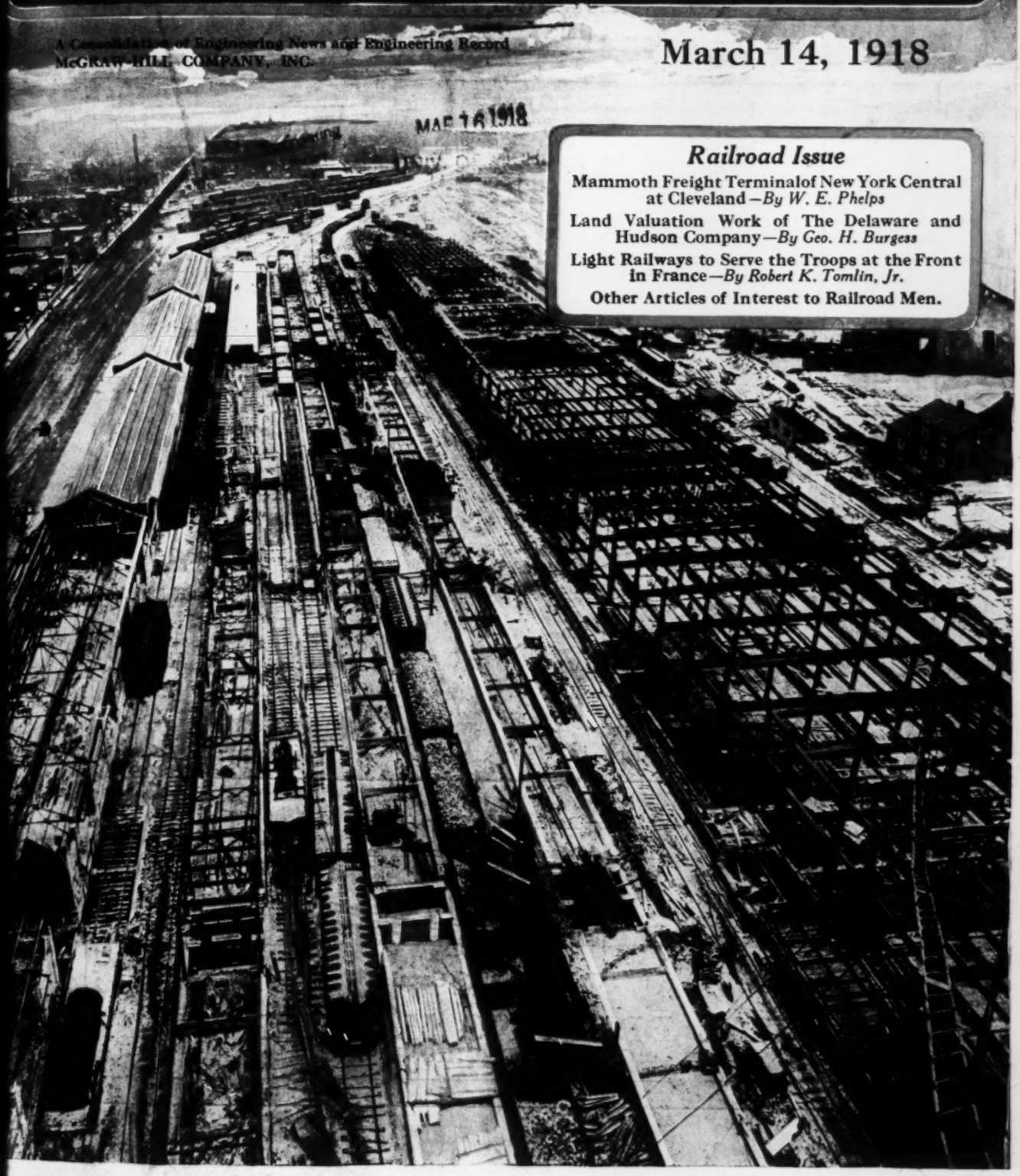
Engineering News-Record

A Consolidation of Engineering News and Engineering Record
McGRAW-HILL COMPANY, INC.

March 14, 1918

MAR 16 1918



Railroad Issue

Mammoth Freight Terminal of New York Central at Cleveland—*By W. E. Phelps*

Land Valuation Work of The Delaware and Hudson Company—*By Geo. H. Burgess*

Light Railways to Serve the Troops at the Front in France—*By Robert K. Tomlin, Jr.*

Other Articles of Interest to Railroad Men.

"We accepted this war
for a just and worthy object and
the war will end when that object is
attained. Under God, I hope it will not end
until that time." *Abraham Lincoln*
June 16, 1864

Drafting Room—The Willys-Overland Co.
Full equipment of 100 drafting machines

Write for 1918 Catalog

UNIVERSAL DRAFTING MACHINE COMPANY
CLEVELAND, OHIO, U. S. A.

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—JAMES H. McGRAW, President

ENGINEERING NEWS-RECORD

A WEEKLY JOURNAL
DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. MEHREN, Editor — CHARLES WHITING BAKER, Consulting Editor

Volume 80 — NEW YORK, THURSDAY, MARCH 14, 1918 — Number 11

A Special Issue for Railroad Men

SPECIAL issues of *Engineering News-Record* have not been frequent, and it is believed that the average reader would not care to have them frequent. Waterworks men, however, have come to look yearly for special issues just preceding their two principal conventions, the road and concrete conventions have been similarly heralded, and this year, the week before the railroad men meet in Chicago, an attempt has been made to give these men something of special value. Mr. Phelps, in his article on the Cleveland freight terminal, does not merely describe a large plant; he analyzes its design. Mr. Burgess, who in a general article in this journal a year ago showed the thorough way in which The Delaware and Hudson Company has gone into its valuation work, tells what his land forces are doing. Another article describes new machines that simplify maintenance. The abstract of the joint committee's track-stress report represents the careful effort of a member of this staff to summarize for the busy reader the 200 pages of matter presented in January before the American Society of Civil Engineers. Mr. Tomlin tells some more of what our railroad men are doing in France. Other articles round out the issue, and give every kind of railroad man, it is hoped, something interesting and useful.

War Emergency Yard Improvements

RECOGNIZING at once the crying need of the railroads for better yard facilities in the war emergency and the impracticability of making extensive alterations at this time, the yards and terminals committee of the American Railway Engineering Association has concentrated its efforts on eliminating minor defects in existing yards. It suggests that each railroad appoint a small committee, made up of an engineer versed in yard design and a practical yard man, such as a yardmaster or yard conductor, to devote its whole time to traveling over the line and making a study of the opportunities for small changes to improve operating conditions. To bring out more clearly the possibilities, a catechism of 25 questions has been prepared. One question asks whether one receiving or departure track, where these tracks are too short, cannot be lengthened to accommodate the maximum train. Another makes the more sweeping suggestion that the movement of traffic in the yard might be reversed. The catechism, broad as it is, will doubtless bring to mind other questions applicable to any particular yard. The committee began its attack on this problem last year, before the Government took over the railroads, and some of the companies felt it impossible to assign men to the task. Under the new regime it should be easy to carry out the plan, and so perhaps lessen the danger of worse congestion than we have yet seen.

Unethical Practices Lower Engineers' Standing

SO LONG as engineers persist in flagrant violations of even the fundamental principles of their code of ethics, it must be expected that engineers will be rated as though they had no code of ethics to live up to or, worse still, failed to honor their code. Within a month in a single Western state, the daily press reported two instances illustrating the kind of ethical transgressions referred to. In one case several engineers were being considered for the position of consulting engineer on work to be undertaken by the city. One of them put in a bid, stating the price for which he would prepare the plans and supervise construction. The amount of the bid was mentioned in the daily press and the city was inclined to accept it, when a telegram was received from another engineer who had also looked over the work, and who hastened to place a bid slightly below the one just filed. Apparently this was a clear case of price cutting such as merchants of the lower class sometimes resort to. In another instance, a small town had applied to the state public utilities commission for a reduction in its light rates. In the course of the hearing the commission's investigators surprised the engineer who was presenting the case for the town by exposing an agreement which the engineer had made with the town for a contingent fee in return for his testimony and services. The agreement was that the money which the town would save on lighting bills for a term of two years, if the desired reductions were secured, would be paid to the engineer if he secured the reduction. The commission's examiners were of the opinion that the testimony of such a witness should not be considered. Ethical matters are not the only ones to be considered in seeking a higher rating professionally; but while such lapses as these from the well-established code of ethics occur, the standing of all engineers will suffer.

New York Subways Must Be Finished

IT IS asserted on good authority that unless some means of readjusting present construction contracts is found it will be difficult, if not impossible, to complete the New York City subways and many other public works. A bill is to be introduced in the state legisla-

ture which will make it possible for administrative bodies to take into account the extreme conditions that have arisen since last April. As noted in the news section of this issue, this legislation would deprive the contractors of all profit from the time this country entered the war, but would make it possible for the authorities with whom they have contracted to pay the actual cost of work done since that date. This proposal, as fair to contractors as can be asked, since it would enable them to finish the work without further loss, and certainly fair to the state, cannot justifiably be opposed on political grounds. The outstanding fact that New York City, almost at its legal debt limit, is carrying fifteen million dollars a year in fixed charges on investments that will be idle till the new system is in operation should alone compel immediate indorsement by the city of the proposed legislation. With its contractors at the limit of their resources, with the delay and expense of reorganization and with the certainty of litigation involving millions and lasting for years should the city permit the contractors to be forced out; and, as the final straw, with the United States Government preparing to undertake work within New York City which may cost more than the sum which will be spent in completing the subways, and the management on which can pay any prices or commandeer any labor or material needed, it is evident that the city is in a most serious situation. It must reconsider its attitude, justifiable in ordinary times, that the contractors undertook all losses incident to the work, and that such losses are no concern of the city, and join hands with them to insure the city and the country against the serious setback that would result from the suspension of this work.

The Miracle of the Mass

NORMALLY the mass of the people follow a few leaders. History is the record, page after page, of the doings of nations under the guidance of a few men. But now and then in the record you come to a story—and it is always a thriller—in which the mass of the people yank their leaders from the head of the procession and move whenever and wherever their whims or their wisdom dictate. Such a page is being written now in the logbook of the world.

Mass movements are the miracles of the day. They are the big surprise. When the war began, our minds ran riot with the expectancy of inventions, of miracles of matter. We awaited the daring developments of wizardry—things wireless, things uncanny.

There have been miracles of matter, of course. In time of peace we would have acclaimed them as marvelous. But we give them a glance and turn with serious interest to the miracles of mass movements. If a chemist came forth now and turned gold into lead, our eyes would still be riveted to the Russian drama where diamonds have become dust, and dust is becoming—what? We look at Germany and Austria. Will the miracles of the mass overcome their own miracles of matter and make ours unnecessary? In England, they tell us, an orderly miracle of the mass is taking place—and in France.

Who doesn't sense the upgathering sweep of it at home? And if your feeling is one akin to fear, is there or isn't there mingled with it and dominating it a sense of relief because many of the hampering grips of the old order are passing into history?

It will be an interesting story when it is written by a future Carlyle; and those of us living in the life of it will understand it better when we read it than we do now. Old phrases will come back to us. "Cost plus" will be one of them. We shall wonder then, not at the miracle of the mass, but at the stark madness of men—we had thought them big men—who played poker openly at a holy moment.

The future historian will be careful to point out, however, some salient facts that we, in the jam of things, may fail to emphasize. He will trace in detail through the nineteenth century the gradual growth of what we call our classes—our employer class, our laboring class, our banker class and so on; and he will underscore the outstanding fact that the poker players were a minority of each class. But to us, living in the turmoil, this fact is not outstanding. Mass indignation does not discriminate. By its very nature it can not discriminate. It is too overwhelming. It is a thing of the heart, not of the head.

The miracle of the mass can wreck us or save us. In all groups there are good and bad, in the moral sense. There are good lawyers and bad lawyers, good employers and bad employers, good engineers and bad engineers, good laborers and bad laborers. If the old classification by professions does not disappear, and that quickly, the outlook is ominous. If the employers stick together *as a class*, and the lawyers *as a class*, the industrial workers *as a class*, regardless of the good and evil among them, Heaven help us! But if the upsweeping protest against the poker players of all classes destroys the class distinctions and aligns the good against the bad, then we are saved.

The hope of salvation grows day by day. Our fight against a ruthless autocracy to whom people are pawns has stirred our deepest age-old moral instincts. The sons of most of us are in that fight. Their lives cannot be gambled with by the poker players of any class. And this feeling is permeating the good men of all classes.

What the miracle of the mass will mean to us in this country lies in a large measure in the hands of the good employers. Are they courageous enough to meet their clear duty, to cut loose from an artificial class grouping, and align themselves, *by their acts*, with the good in the new moral grouping?

What will the future Carlyle say of them?

The Track Stress Committee's Work a Brilliant Piece of Research

A MEASURE of personal appreciation and thanks is due the committee on stresses in railway track from every member of the engineering profession. The committee has written a new page in the book of engineering. Its investigation is a classic. Of direct benefit to the world, the work stands to the credit of the whole profession.

The problem placed before this group of volunteer workers was difficult—among the most difficult in the whole range of engineering practice. It grew out of

a century of empirical development, in all of which time hardly a rudiment of track science was developed. Complicated by many elements of variation, the problem seemed to defy scientific analysis. A bed of earth, a stone pile, rough timbers and steel rails spiked to them form a combination which, continuously modified by settlement, decay, frost, the spike maul and the tamping bar, is an unpromising subject for the application of mechanics. Yet the committee, without false steps or initial failure, succeeded in bringing railway track within the scope of engineering science.

That keen insight guided the planning of the tests is evident from the general facts. And all who have done research work will recognize that the preparations for the experimental attack involved admirable skill in designing instruments and conducting difficult experiments. Without this skill, indeed, the whole investigation would have yielded empty or misleading results. But, no less important, an amount of labor really vast in its proportions was spent on the actual testing operations. Only through a prodigious massing of individual test results did the final figures acquire such generality as to make them an adequate basis for broad deductions concerning track action. The value of mere quantity of work is not often so clearly apparent as here. Hard work is what made the committee's research a classic.

A fourth indispensable factor in the success of the research is apt to be overlooked. This is the element of coöperation. Its influence on the work was so great that in recognizing it one is apt to be inspired with renewed belief in coöperation, a power which has not been accorded as much recognition in engineering as it should receive—or as it may receive during the next generation.

Railway companies, steel makers, technical colleges and individual engineers gave their help to the track-stress work. Standard track in regular service was made available for testing, new rails of various weights were supplied and the committee was given the unusual opportunity of preparing sections of test track by which the influence of a single factor of variation could be studied separately. Locomotives and their crews were placed at the disposal of the test parties with broad-minded liberality. By virtue of this abundance of resources a complete comprehensive range of conditions could be subjected to study. Without it the committee might have deduced various interesting probabilities, but could never have reached the certainty of proof. Had the work not been aided by such remarkable coöperation, only a few track and load conditions could have been investigated. Many years of piecemeal experimentation by different men in different places would have been required to bring together the variety of test data on the effect of track variables which we now possess. This loss of time has been avoided, to the profit of all.

But more has been gained than merely time. Unconnected pieces of research by different men do not fit together well. New elements of variation are brought in, results cannot be compared directly, and in consequence combined tests amount to far less than this sum; the lack of coördination produces a great loss. In the committee's work, on the other hand, all the resources and all the effort expended were fully coördinated. The resulting gain can hardly be overestimated. It is by no means extravagant to credit the comprehensive scope of the test results primarily to the coöperation brought to bear on the work. Our appreciation should therefore address itself not only to the members of the committee but also to those who helped in concentrating upon the problem such an abundance of test material and resource.

Administration Must Undertake Campaign of Railroad Construction

ONE of the greatest American military authorities recently declared that in military operations transportation is the most essential element of all. The events of the past winter have brought home to the public as never before that in the peaceful operations of industry as well, transportation has become an absolutely essential element. In fact transportation has become as truly a necessity of life at the present day as food and clothing and shelter. It has been demonstrated this winter in terms of actual human suffering that mere clogging of the channels of transportation will very quickly make the people of busy and prosperous cities idle for lack of work, cold for lack of fuel and hungry for lack of food.

The events of the past winter, too, have demonstrated that "preparedness" in this vital matter of transportation is as important to the prosperity of a nation and the individuals comprising the nation as preparedness in military matters is to national defense. Locomotives and cars cannot be built overnight at a time when congestion of traffic reveals their shortage. Their building must be begun long in advance of the need. The same thing applies to all the other facilities on which transportation depends—rails, structures, ships, wharves, terminals.

Another thing which has been made more clear than ever before is that the overloading of a railway transportation system is fatal to its successful operation. At the very time when the demand is greatest and most urgent, the movement slows down. In other departments of industry, whenever demand exceeds supply business is brisk, prices rise and under this stimulus production increases to meet the needs. In the railway business, however, whenever demand exceeds supply the result is a clogging of the whole machine.

The obvious lesson to be drawn from the trying experiences of this winter is that a larger "factor of safety" must be provided in the capacity of transportation systems. There must be in normal times some surplus of locomotives and cars and terminal capacity, and the growth of traffic must be anticipated by the provision of facilities to carry the traffic.

Of course it will cost money to furnish a factor of safety in railway-traffic capacity. Factors of safety always cost money; but no one today doubts their necessity. A few millions of dollars spent in 1913 for extra rolling stock and terminal facilities would have saved a great many million dollars this year in loss of wages, reduced production, and arrested activity of an entire nation. During the past winter, with the whole world on the edge of famine, the Governor of

Iowa made an urgent appeal for cars to move the corn crop, declaring that millions of bushels would be spoiled unless the railways could furnish cars to move it promptly. What is true of Iowa corn is true of every other commodity. The farmer, the merchant, the manufacturer, the miner—all are helpless unless they can have transportation to move their products to market.

Whose business is it to see that this provision to meet public necessities is made? Hitherto, under the competitive system, private enterprise has been the sole reliance. It has been assumed that railway companies would keep themselves supplied with sufficient cars and locomotives and all necessary facilities to accommodate the traffic. It has been assumed that needed extensions of lines and terminals would be made as they were required because someone would find it profitable to make them.

It is plain enough that private enterprise can no longer be relied upon for this. The directors and managers of the railway companies, now under Government control, are continuing the routine operation of their properties; but what railway company is at this time working on plans for large extensions of equipment or facilities? Why should it undertake such work when it is uncertain whether or not its property will ever be turned back to its possession and control? Further, even if it is turned back, all signs indicate that the era of competition in American railroading has come to an end, and with it goes a large part of the incentive for undertaking extensive new works.

There are other reasons, too, why we can no longer rely on the railway companies to initiate and push to a successful conclusion the work of extending and rebuilding our railway systems. The principle is well established now that a railway or other public utility may charge such rates and only such rates as will yield a reasonable return on its actual capital invested. But what the public and the courts generally construe as a reasonable return leaves no profit above ordinary interest rates sufficient to attract the promoter, or to encourage those in charge of the destinies of existing companies to back new enterprises which necessarily involve some element of risk. It is absolutely useless to protest against this revolution in economic thought and practice. The thing to do is to recognize that the revolution has come; that it squares on the whole with public opinion and hence has come to stay; and that henceforth other means than private enterprise must be relied on for the necessary development of our railway facilities.

Let us emphasize the words, *necessary development*. The time to prevent another coal famine next winter and the winter after that, is *now*. Director-General McAdoo himself has recognized that the Government in taking over the operation of the railways cannot and ought not to stop the work of expansion and extension. Rather it should give new direction and impetus to the development of the American railway system and make up for the slackening in the work of improvement during the past five years.

This does not mean merely buying additional cars and locomotives—although these must be bought, of course. It means the planning of terminals, connections and extensions, freight stations, transfers, bridges, tunnels and whatever is needed to make the railway system of the country equal to the traffic demands.

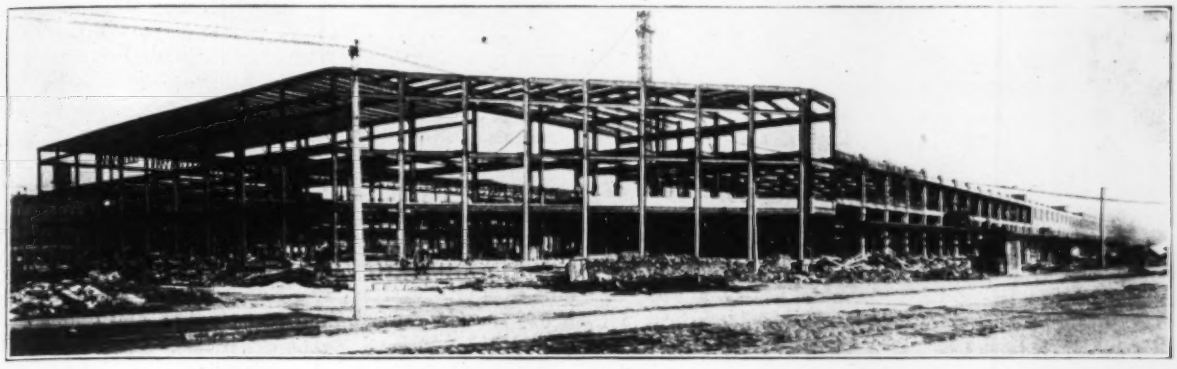
But it is said that the exigencies of the war compel the restriction of capital expenditures to whatever will help win the war, and that there is no money to spare for such railway development; and further, that at present the high prices of labor and material make it unwise to expend money on extensions. The answer to this is that our transportation system here in America is as important a tool in our prosecution of the war as the railways our engineers are building in France. At this very time, ships are waiting on the Atlantic Coast for the railways to bring them grain cargo for shipment to the Allies.

Of course this is not the time to spend any money, material or labor except where it can be shown that the expenditure will be worth while in the practical immediate effect on war conditions; but after the experience of the past winter, no argument is needed that the expenditures necessary to give the railways capacity sufficient to handle the country's business is fully justified.

And something besides money, and even more important than money, is called for; that is, expert intelligence to direct how and where the money shall be spent. There are hundreds of ways in which money can be profitably spent for the more economical operation of railways, but out of them the ways should be chosen that will do most to increase traffic capacity.

For example, the congestion of traffic during the past winter has been chiefly congestion in yards and terminals. Attention may well be concentrated, therefore, on measures to increase the capacity of terminals or otherwise reduce the pressure upon them. One plan for effecting this which is receiving more and more attention from traffic experts is the construction of belt lines to divert through freight trains around large cities. It is advantageous not only to the railway company to avoid delay and expense by keeping its thorough trains clear of the crowded yards at great cities, but also to the business interests of the city itself, for they are at least as much interested in keeping their own railway yards and facilities free from blockades.

It is as yet too early to say what the future of the railways is to be, and so it may seem unwise to embark on any schemes for railway expansion. On the other hand the very object of the Government control is to increase the capacity of the railways to handle traffic; and if new construction is the best means of accomplishing this there should be no hesitation in undertaking new construction wherever its necessity is demonstrated. The planning of these new facilities and the selection of those of greatest importance which can be most rapidly made available to relieve traffic congestion is a problem calling for the abilities of the best engineers and traffic experts in the country. An organization made up of such men should be brought together and set to work at this task as promptly as possible. The introduction of economies in the railway service by eliminating wastes which are due to competition is valuable and important; but it is trivial compared with the importance of increasing the capacity of the country's transportation system. It was that necessity which compelled the taking over of the railways by the Government.



New York Central Builds $4,000,000 High-Level Freight Terminal at Cleveland

Plant Almost Completed Near Business Center Has Separate Inbound and Outbound Houses 1262 Feet Long—Bascule Trucking Bridges Connect Island Platforms—How Widths of Buildings Were Determined

By W. E. PHELPS
Assistant Engineer, Office of Consulting Engineer, New York Central R.R., Cleveland

THE local freight business of the New York Central R.R. at Cleveland having entirely outgrown its house and switching facilities, which could not be materially enlarged because of generally cramped conditions, the company is completing in a new location, at a cost of more than $4,000,000, a comprehensive local freight terminal comprising separate inbound and outbound freight houses with house tracks holding 235 cars and team yards with tracks holding 550 cars, with independent classification and storage yards of about 1000 cars capacity. The terminal is near the heart of the city's business district. The improvement includes the construction of a branch line 3½ miles long to serve the new facility. The entire layout has been designed as a self-contained unit in which road trains can be received and made up, and is noteworthy not only for its unusual size and completeness but for many features of construction and operation embodied in the plans.

The city's main business district lies nearly 100 ft. above the level of Lake Erie and its tributary, the sinuous Cuyahoga River. Both the half-mile-wide river valley and the lake front are occupied largely by railroads, factories, lumber yards, steel blast furnaces and other industries utilizing water transportation. Most of the principal freight stations are on this lower level, which is bordered by naturally steep bluffs, and the streets from it to the upper level all have long gradients of 7% or worse, which constitute a great drawback in trucking freight, causing charges of about 20c. per ton more for hauling from these low-level stations than from those on the upper level. This competitive handicap and the congested condition of practically all the downtown freight stations, both as to overcrowded houses and poor switching facilities, has resulted in a more or less general effort by all the railroads to secure more favorable locations on the upper level. The first of such stations was built by the Pennsylvania company about 12 years ago, and proved immediately successful, as evidenced by a surprisingly large increase of business.

Within the last four years material changes in this direction have been planned, some of them being now under construction. The Cleveland & Youngstown R.R., originally projected to provide fast transportation service for the development of high-class residential real estate east of the city, is the nucleus around which a number of other lines (steam and electric) have planned improved joint passenger terminals, and some have built or are planning to build improved freight facilities on approximately the level of the business district. The New York Central terminal is, however, the first of these projects, in connection with the Cleveland & Youngstown, to be built along permanent lines, as it is also the largest and most important.

The terminal is reached from the Cleveland Short Line, a New York Central belt line around the city, by a double-track line 3½ miles long, built for most of the way on four-track construction of which one-half is occupied by the Cleveland & Youngstown tracks. Grades are separated at all streets, all but two of which are crossed overhead, and two railroads are crossed overhead. The bridges are designed for E-60 loading and are of various types, comprising several reinforced-concrete arches, one three-truss four-track bridge, and several heavy girder bridges.

There are two long fills 75 and 60 ft. high, respectively, on the two-track portions of the line, while the so-called "lower yard," which is for storage, classification and making up trains, and is in two short sections, inbound and outbound, of about 500 cars capacity each, both arranged for gravity switching, is all on a fill 35 to 66 ft. deep. This fill has required about 1,250,000 cu.yd., the bulk of which is slag and refuse, which the railroad is required to take from and dispose of for the blast furnaces and industries on its line. Underlying

the yard is a mile of box-section reinforced-concrete sewer, varying from 8 x 8 ft. to 10 x 10 ft., carrying the waters of Kingsbury Run, in the low-lying valley of which the yard and a large part of the line is built, this requiring in addition a large amount of smaller sewer on the upper portions of the line.

Despite the heavy construction, the grades on the line are necessarily heavy. From the overhead crossing of the Pennsylvania company's tracks, about ½ mile from the Short Line connection, there is a 2% descending grade for about a mile to the lower yard. From the middle of the lower yard there is nearly a mile of ascending 1.27% grade to the "upper yard" or terminal proper, which is practically level.

This upper yard occupies an irregular shaped area of about 35 acres, about ½ mile long and averaging 600 ft. wide, in which are located 27 team tracks with a capacity of about 550 cars, and the terminal station buildings served with eight tracks, with a total capacity of 235 cars.

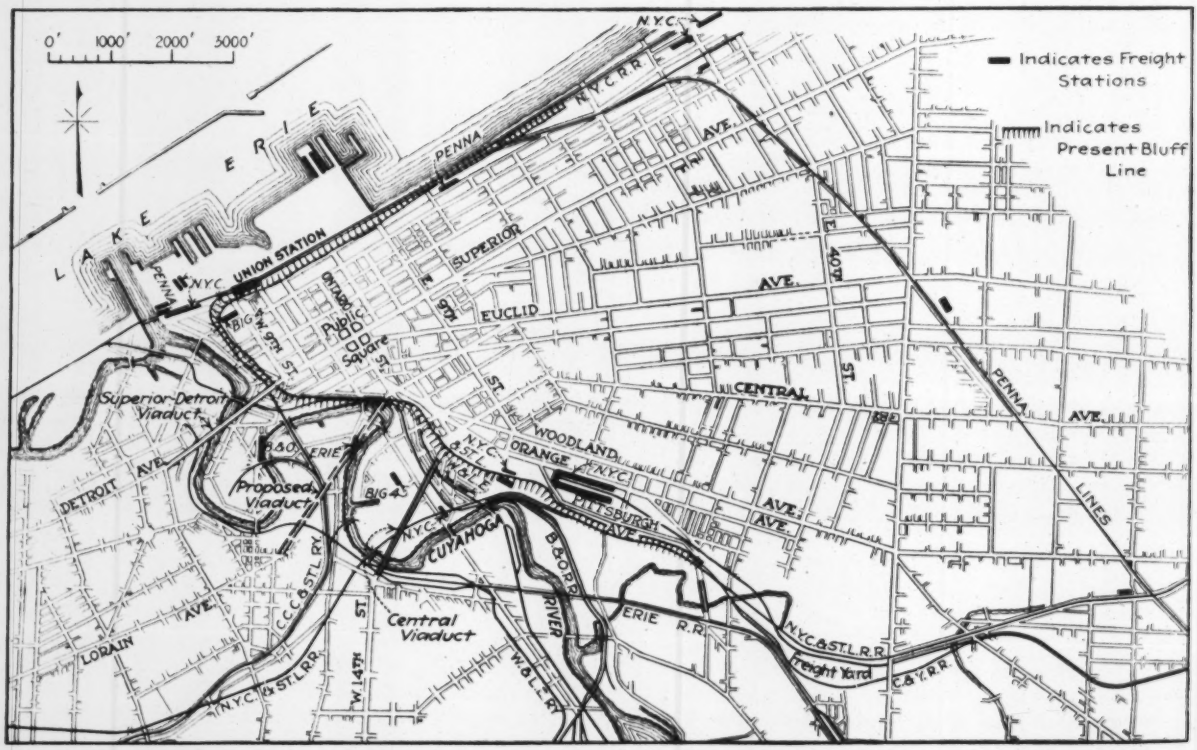
The terminal is built on an area formerly densely populated and crossed by many streets and alleys. In consequence of the vacating of these streets the city required many street widenings and extensions in the immediate vicinity, and the construction of Mayflower Road, an entirely new 80-ft. street. All of this new street work was paved with Medina stone or Durax block.

The building layout consists of two separate and parallel houses 1262 ft. long, the inbound 75 ft. and the outbound 38 ft. wide, the two being 156 ft. apart and connected at the west end with a platform 50 ft. wide. Above this connection is a building containing the two floors occupied by the offices, this being carried around over 296 ft. of the outbound house; elsewhere the outbound house is but one story high above the street, but the inbound house has two stories above driveway level, with provision made in the foundation and partly in the structure for carrying four additional floors. Under the west 485 ft. of the outbound house is a basement containing coal storage, boiler, pump and fan rooms and housemen's wash, locker and dining rooms. The basement continues around under the westerly platform, where it will be used for repair shops, tractor garage and cashier's vault; under the whole of the inbound house for freight handling and storage, and under the adjoining platform for pipe galleries.

Between the buildings are the tracks and platforms. Adjoining the inbound house is a covered platform 12 ft. 3 in. wide, between which and the outbound house (which has no platforms adjoining) are three covered island platforms 16 ft. 6 in. wide, alternating with four pairs of tracks on 12-ft. centers. The centers of the tracks are 5 ft. 9 in. from the edges of platforms, while that of the track adjoining the outbound house is 6 ft. from the face of the house.

Hand-operated double-leaf wooden bascule bridges, 16 ft. wide, connect the platforms and houses at the east end and at two intermediate points. These bridges divide each track into two 9-car sections and one 10-car section, making the total capacity for the eight tracks between the houses 224 cars. Eleven additional cars can be placed along the two 24 x 300 ft. uncovered platforms for handling automobiles, with ten more east of the island platforms for icing.

The longitudinal panel spacing in both buildings is



LOCATION OF BLUFF LINE SHOWS THAT MOST OF CLEVELAND'S FREIGHT STATIONS ARE ON THE LOW LEVEL

21 ft., to correspond to an assumed car length of 42 ft. Measurements of a large number of cars, taken at random in the yards, showed an average length of about 40 ft. 5 in., with many cars more than 43 ft.; and as car sizes are constantly increasing provision was made for a 42-ft. average.

Steel side posts support the island platform roofs, and are spaced 42 ft. c. to c. Posts so spaced will always clear car doors, because of the comparatively short sections in which the plant is divided, and analysis of different arrangements of roof supports led to the conclusion that because of practically leaving the full width of the platform clear for trucking, the arrangement adopted was best for operation.

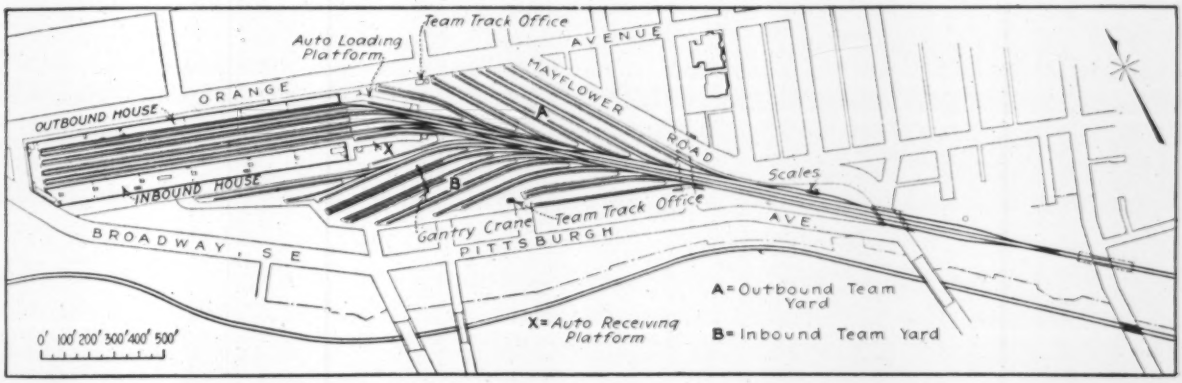
Structural steel construction has been used throughout, except as noted, for the buildings. The inbound house is three panels in width and has concrete floors of the slab-and-beam type and a flat roof covered with precast concrete-slab roofing tile. The latter is also used over the office portion. The inbound house and office sections are of fireproof construction throughout. The sloping roof over the one-story part of the outbound house is of cement tile on exposed steel trusses. The outbound house and the portions of the offices over it are entirely clear of posts. Suspended canopies overhang each of the driveways adjoining the buildings and the platform on the track side of the inbound house. The island platform roofs are of timber, supported on steel side posts and longitudinal trusses, and covered with four-ply built-up asbestos roofing.

Rather unusual provisions have been made for taking care of future additional floors on the inbound house. While considered necessary, it was not desired to spend much money for this; consequently the structural steel for all the columns was built only heavy enough for present requirements, but the footings were built large enough to carry the full ultimate load of 6 tons per square foot, which was considered justifiable in view of the perfect coarse sand and gravel foundation. Load tests were made and certified results submitted to the city building department to safeguard this plan in the future.

Additional strength for the exterior columns is obtained by heavily reinforced concrete surrounding the structural steel, built now to prevent future defacement of the exterior brick walls, while the interior columns are now incased in fireproofing tile, to be removed and replaced with reinforced concrete when the need for strengthening arises. The flat roof is carried on light beams which likewise are incased only in fireproofing tile in plaster. They are bolted together so they can be removed and replaced by floor-beams carrying the standard floor load of 300 lb. per sq.ft., the roof beams being used again higher up.

Vitrified paving brick was used generally throughout the buildings for both exterior and interior walls, except on the three-story part, where the exterior is white porcelain brick with "granite" terra cotta trim. The use of vitrified shale brick was considered necessary to withstand the hard usage, inside and out, to which a freight house is subjected, and in addition to this the paving brick gives the exterior walls a strikingly pleasing appearance.

Steel doors and column guards everywhere prevent breakage of brickwork and columns, and timber fenders along the driveway side of each house are placed to prevent vehicles striking and damaging the buildings. All concrete door sills and platform edges are protected with steel angles.



TRACK LAYOUT FOR FREIGHT HOUSES AND TEAM YARDS AFFORDS AMPLE OPPORTUNITY FOR SWITCHING

The floors of platforms and of the first story of the two houses are of 1¼-in. carbolineum-treated matched maple, except on the uncovered automobile-handling platforms, where both cement and asphalt block are used experimentally. Maple flooring was adopted, after exhaustive consideration of every known type of flooring, as representing the best and most satisfactory practice. In general it is laid on a plank underfloor, bedded on a bituminous concrete, but to a limited extent the flooring is placed direct on a Nalecode concrete underfloor.

The third-floor office and the basement of the inbound house will have floors of cement and granite screenings; the second-story floor will be of cement treated with a metal hardener. The second-floor office will have a linoleum-like mastic floor finish. On account of the exposure of the under side of this floor to outside temperatures it will be specially insulated with 2 in. of cork in the subfloor construction.

The one-story part of the outbound house has a concrete subfloor, supported on the filling between the foundation walls, but on the island platforms the underfloor will be laid directly on sleepers bedded in the granulated slag fill, which will arch between the walls and furnish a satisfactory support.

Doors 9 x 9 ft. are placed along the track side of the inbound house in every second panel, opposite the car-door positions. Along the track side of the outbound house, where there is no platform, doors 9 ft. high occur also in alternate panels, but these are 19 ft. wide to eliminate the necessity for close spotting and consequent cutting of cars. The doors along the driveway side of each house are 9 x 9 ft., and the fire-doors in the houses are the same height, but generally 12 ft. wide. All doors are of the rolling steel-curtain type.

The platforms and track-side doorways contain slots 18 in. from the face, formed by two angles separated by spacers, for holding the heel lugs of ¾-in. steel gang-planks used to bridge from the walls to the cars. These planks are about 3 ft. 6 in. by 3 ft. 4 in., arched 3 in. to fit car floors of any height. The platform and doorway edges are beveled to 1 in. below the slots to reduce the amount of arching.

Seven electric elevators—one 9 x 22-ft. 10-ton, five 8½ x 11-ft. 6-ton, and one 8 x 9-ft. 5-ton—equipped with car gates and electrically operated landing gates are installed in the inbound house, with a pushbutton automatic service elevator in the office portion of the outbound house; doors are provided generally on opposite sides of the shafts to allow non-interfering in and out movements of trucks. The 9 x 22-ft. elevator at the east end of the house is for handling automobiles received in shipment, but can handle loaded auto trucks if ever required.

The elevators are located with specific reference to the bridges and the proper relation to the trucking runways and storage piles. Structural provision has been made for seven more elevators in the inbound house, for installation only if the four floors expected to be built in the future are added. An inclined elevator from the basement to the first floor of the inbound house has been provided for, but will not be installed at present.

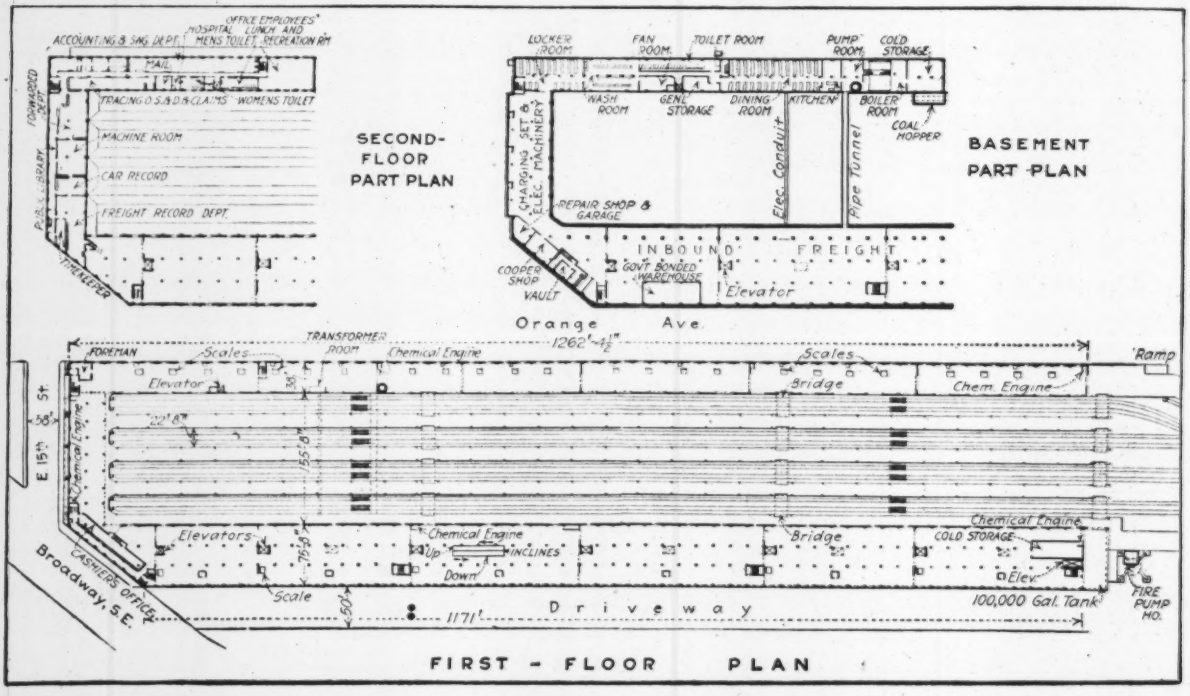
Twenty-four 6 x 8-ft. 6-ton automatic dial platform scales are provided in the outbound house and six in the inbound house.

The heating plant and coal storage are located in the basement of the outbound house. The electrical installation is very complete and of the highest efficiency. The office lighting is indirect, and the house lighting direct, providing 4 and 2.5 cp., respectively, at the floor. Plug connections for car lighting are provided opposite each car door.

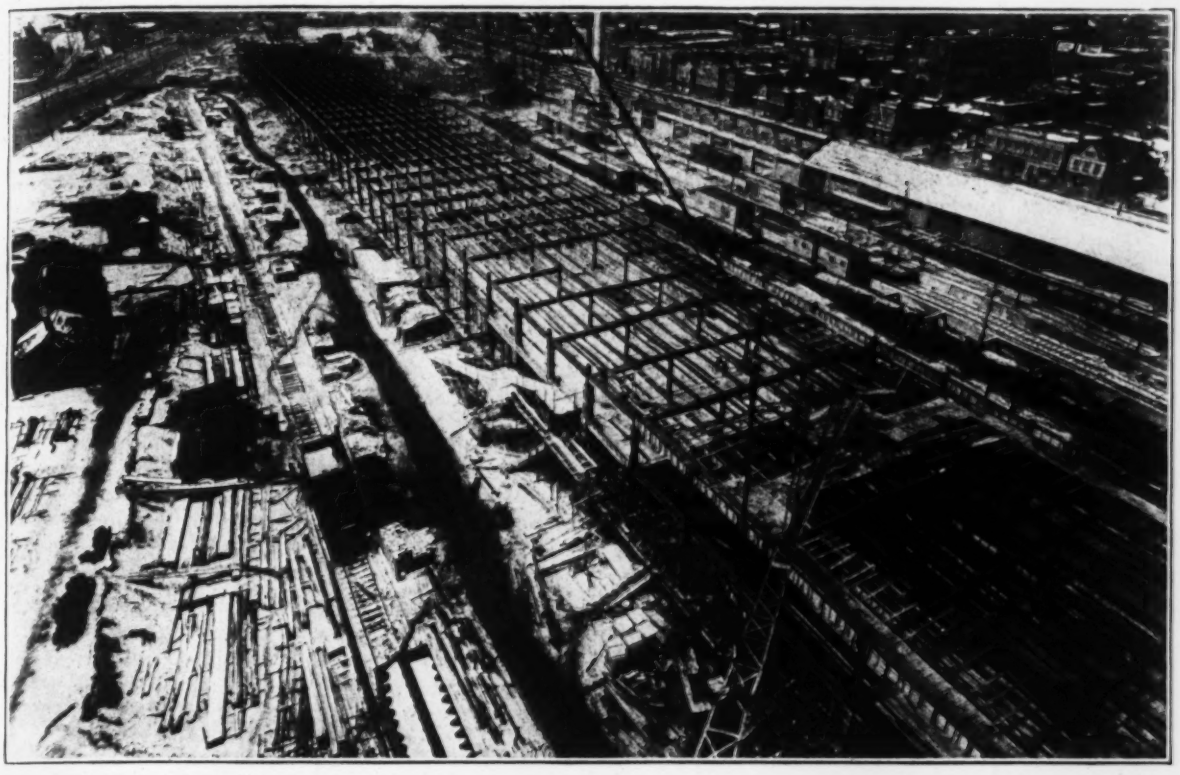
Automatic sprinklers in the offices, numerous fire hydrants in each house and on the platforms, with a 150-hp. electric fire pump supplied by the 150,000-gal. concrete reservoir under the platform at the east end of the inbound house, and numerous chemical fire engines, supplemented by a combined watchman's detector box and fire-alarm system and three city alarm boxes, distributed throughout the plant, constitute the present fire protection plans. This will probably be augmented by an elevated tank and sprinkler equipment throughout the inbound house when that structure attains its full height.

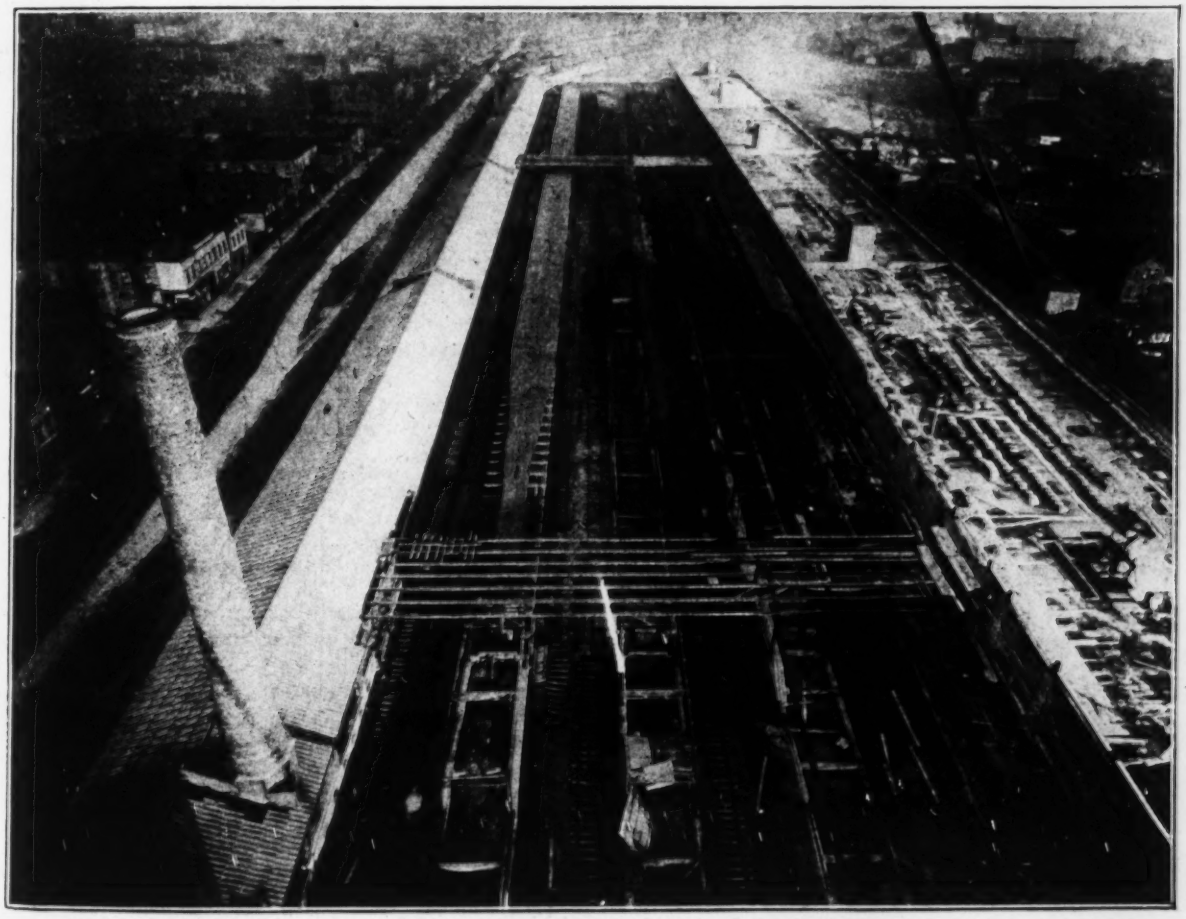
A private branch telephone exchange, giving automatic intercommunicating service to nearly 100 stations in the offices, houses, on the platforms and in the yards, with "manually operated" service to the Bell exchanges, is to be installed.

As the size of the plant has made it impossible to consolidate all the office functions, as is usually done, without inconvenience to patrons, certain sub-offices are located at convenient points in the plant. The public convenience has been carefully considered in the arrangement of the general office, all subdepartments with which the public deals being located along main lob-



GENERAL PLAN OF HOUSES AT TRACK LEVEL, AND ENLARGED PART PLANS OF BASEMENT AND SECOND FLOOR



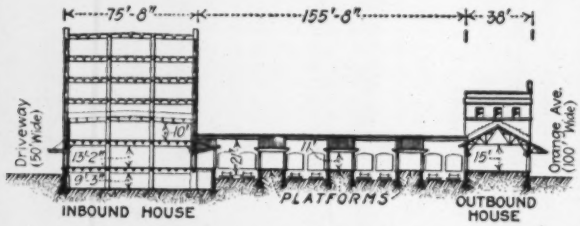


THESE VIEWS TAKEN THREE MONTHS APART FROM DIFFERENT POINTS SHOW THE MAGNITUDE OF THE TERMINAL AND THE PROGRESS MADE FROM NOVEMBER, 1917, TO FEBRUARY, 1918

bies. The cashier's office is located with exceptional convenience on the first floor.

Unusual facilities are provided for the comfort of all employees, and ample space has been allotted to them for rest and recreation, eating and locker rooms. A hospital room for first-aid treatment is provided on the second floor. In addition to the main toilet rooms, small toilets are located at suitable points.

There are several more or less unusual operating facilities, none of which has excited more interest than



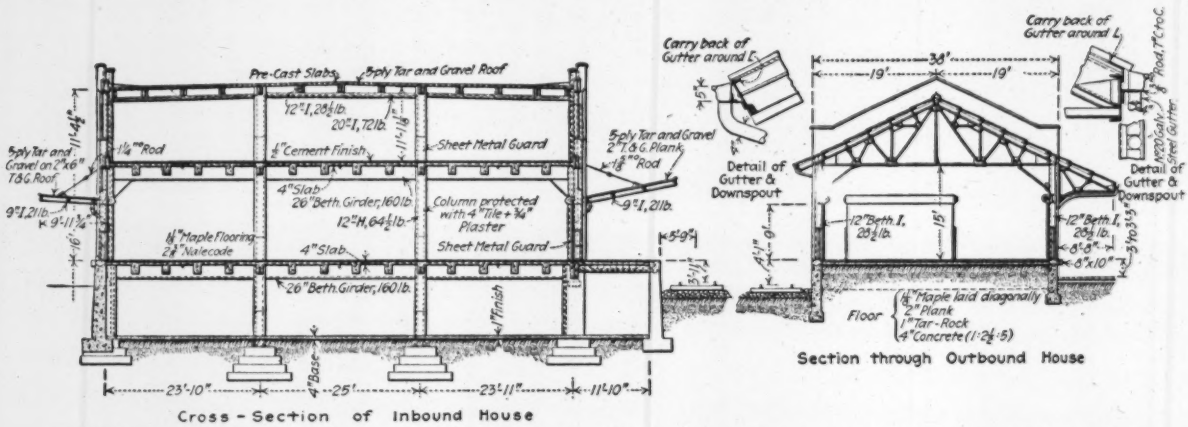
GENERAL CROSS-SECTION OF FREIGHT HOUSES

the three lines of trucking bridges, which with the head platform provide four smooth trucking surfaces, connecting all units of the plant at all times except when cars are being moved and the bridges are up. Exhaustive tests made at the Pennsylvania R.R.'s Mantua (Penn.) transfer plant several years ago, and experience at other points where such bridges are used, show that truckers can well afford to, and do, make long detours to cross from one platform to another on the smooth bridge surfaces rather than cross over platforms and through cars of widely varying heights over the irregular surfaces of a series of gangplanks—the value of bridges depending largely on the ratio of length of detour to the number of cars to cross through.

For the present the bridges will be hand-operated, and with no special protection other than lights to prevent them from being run into by trains, although provision is made for both power operation and interlocking with derails at the east end of the platforms, and either of these can be easily applied if ever found necessary. Experience elsewhere, however, has shown that the lack of special protection has tended to make the switchmen careful of the bridges, rendering such protection unnecessary.

In the present transitory state of freight-handling methods, with no one method generally accepted as best or final, the plant is designed to provide as well as possible for either hand or mechanical operation, or a combination of both. The present plan is to use to as great an extent as practicable, and principally for outbound freight, four-wheeled trailer trucks with electric tractors, working in trains. The plan of operation (for outbound freight) provides for train movements generally westwardly in the outbound house and eastwardly on the platforms, the tractors picking up in the house the trailers loaded with freight as received from shippers at street doors, taking them to the west-end platform, which will be a "classification yard" where the trains will be broken up and switched by hand in proper order into classified trains to move eastwardly along the island platforms, where the trailers will be cut off in order at their respective cars. The main movement of the tractors will thus be generally circuitous, looping around the headhouse platform to the island platforms and back into the outbound house over the various bridges.

Pending an actual tryout of this plan, the one-way movement in the house, on the platforms and across the bridges is expected to more than compensate for the longer average haul required to take all freight to the west end of the plant for classification, by lessening of confusion and congestion generally. There will be no lost motion of the tractors, as, once started, there will be four movements in a complete cycle of operation, as follows: (1) Picking up loads in the house and taking to end platform; (2) picking up empties on the platforms; (3) distributing empties in the house, and (4) distributing loads on the platform.



CROSS-SECTION OF TWO-STORY AND BASEMENT PART OF INBOUND HOUSE, AND OF OUTBOUND HOUSE

For the initial installation three tractors of the three-wheeled type and 200 four-wheeled trailers with 3 x 6-ft. platforms 20 in. above the floor will be used. This installation will be supplemented by such hand trucks and other trucking equipment as will be necessary.

Inbound freight will probably be handled very largely on hand trucks. This includes transfer freight, which has to be taken to outbound cars, and the bridges will be used extensively for this movement.

Outbound freight is delivered to the house principally during the afternoon, but to accommodate it whenever

it may come, a full "permanent set-up" of empty cars will have been placed in the plant before morning, to fill during the day. Daily variations in the amount of freight for any given destination, particularly large cities and transfer points, renders it impossible to allot the exact number of cars required for such points in the regular set-up, and a percentage of "extras" is required to accommodate any overflow, these being used only after the regular cars are filled. To reduce as much as possible the confusion arising from these irregular changes from "regulars" to "extras," which usually occurs in the rush period, a special telephone system, similar to a train-dispatching system, by which the foreman's office can call all or any part of the outbound receiving clerks at one time and immediately advise them of all such changes, is provided. This is believed to be an innovation in freight handling and is expected to result in a considerable operating economy.

A pneumatic-tube installation between the outbound checker's booths, foreman's offices and proper departments of the main office permits more rapid transmission of bills than the usual messenger service.

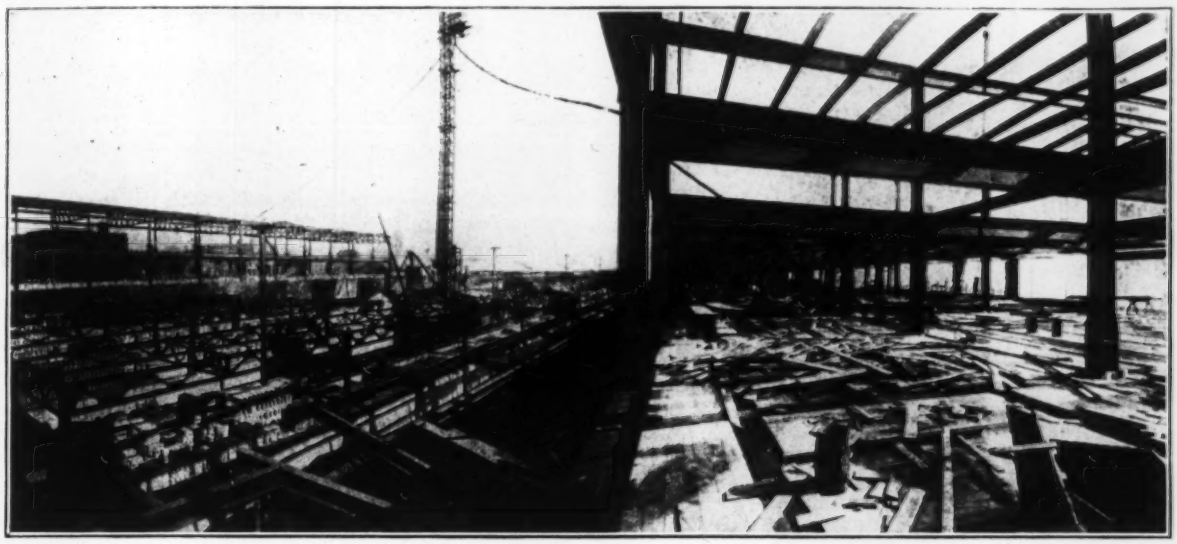
A cold room, for protecting perishable freight held for shipment or delivery, is located on the first floor of the inbound house, the temperature in which is regulated by an 8-ton refrigerating plant, and above this room is an ice storage room containing ice primarily for icing cars.

A prime requisite of economical and rapid freight handling in a big house is the ability to switch cars in and out promptly, and the terminal yard has been arranged with special attention to this feature, the track arrangement permitting several engines to work in the houses and team yards at one time without interference.

The team-track facilities provide for an ultimate development with about 550 cars of standing room, although for the immediate present little more than half of this is being constructed. In nearly all cases the team driveways have a clear width of 40 ft., this unusually liberal width being determined as necessary to permit the longest auto truck to stand backed up to a car without blocking a driveway. The tracks have an average length of 20 cars, permitting easy switching.

So far as it was available, the old Medina stone block taken up in connection with the company's widening and repaving of streets in the vicinity has been reused on a 6-in. concrete foundation for the 50-ft. driveway alongside the inbound house, and for other driveways subject to heavy traffic. Some driveways which had to be opened for business in December were surfaced with an 8-in. crushed-slag macadam, at subgrade height, with the intention that a permanent surface of some sort can later be applied on this as a foundation.

Brick team-track offices 20 x 35 ft. will be provided for each of the team yards, these offices to be self-contained, with toilet facilities, for the forces occupying them and working in the yard. A 9 x 20-ft. 20-ton auto scale will be installed in connection with each of them.



STRUCTURAL FEATURES OF BUILDINGS AND PLATFORMS AS SEEN FROM INNER SIDE OF INBOUND HOUSE

The plan contemplates a gantry crane with 25-ton main hoist and 5-ton auxiliary hoist spanning one driveway, with cantilever arms reaching out over the driveway adjoining on each side, giving a working range of both hoists over four tracks and three driveways. This crane will operate on a runway approximately 700 ft. long, and it is possible to add a second unit whenever business requires.

The study for the size and design of this plant developed some interesting data. Analysis showed that the growth of the city's population for many decades has averaged 4% annually compounded, while all available freight records when reduced to a common basis showed a corresponding increase in freight handled of about 7%; and these data, with certain assumed immediate increases in business due to the new facilities, were used to determine approximately for how long the size of facilities provided will fulfill the freight requirements.

A house length of about 1250 ft. was adopted. This

length was determined by the possibilities of the ground layout and analysis of experience elsewhere, which indicated that this was about the extreme length for economical handling of freight, particularly if by hand. The reason for this is that all the cars in the outbound set-up have to be available for any transfer freight received in any inbound car, or for freight received at any door of the house. To a limited extent outbound freight receipts can be regulated by receiving freight at most convenient doors; but inbound freight received in any car has to be trucked to its proper location (assigned alphabetically and by firms) in the house to await delivery.

Investigation showed that the tonnage handled at several busy New York Central inbound houses averaged about 135 sq.ft. net floor area for each ton of freight handled per day, and that figured approximately 150 sq.ft. gross area. Houses where the wagon spaces were apparently a factor in limiting the daily business showed an average of but 13.5 tons per day per door. Certain factors representing the value of improved facilities, such as roomier driveways and heavier loading per unit due to the increasing use of auto trucks, were applied to this figure, the result indicating that 15 tons per doorway was about the amount of freight which could be handled. To keep the operations confined to as few floors as possible commensurate with economy in the use of land, and reasonable trucking widths, three floors (for the freight house proper) were determined on. Applying the above results, one doorway would deliver an average of 5 tons for each floor, serving three floors of a gross area of 5 x 150 sq.ft. each, which on the original assumption of doors spaced 10 ft. c. to c. indicated a width of 75 ft. As these figures are necessarily based partly on assumed values they are only closely approximate, and the 75-ft. width was not decreased when the panel spacing was changed from 20 ft. to 21 ft., with proportionate reduction in the number of door spaces.

If the four additional floors are built as expected for warehouse purposes, it will probably be necessary to provide additional facilities consisting of a driveway at the level of the third floor (either inside or outside the building as desired), reached by ramps at each end of the building. As warehouse trucking business is largely cityward, these ramps can be on quite steep grades.

With the inbound-house capacity determined by multiplying the length of 1250 ft. by 1½ tons of daily handling capacity per linear foot (the total for three floors) to be 1875 tons per day, the annual capacity of the full house is easily determined, this figure being subject to one more modification, as all the figures used in the above calculations were for the full capacity of the house, the business of which fluctuates greatly during the year. Calculation showed that the average of freight handled in the New York Central Cleveland houses was about 88.6% of the amount indicated by the maximum month's tonnage, and the resulting figure was used to give a corrected yearly tonnage capacity. Considering these figures with those of the city's rate of growth, the house is estimated to meet the New York Central's needs fully until approximately 1930. (This article was prepared prior to the taking over by the Government of the operation of the railroads, and predictions as to future needs will be qualified by any action the Government may take toward consolidating the freight business of various roads into large terminals.)

For the outbound house 38 ft. was determined to be wide enough to provide plenty of aisle way and working room, with the little storage room needed, which is all that is required for the house proper.

As much space as possible was given the track set-up. It is recognized, however, that when the outbound business has reached a point corresponding to the ultimate capacity of the inbound house, far more cars will be required than it is possible to set on the six tracks available for outbound business, and that the additional car capacity can be provided only by doubling the set-up by making noon and early afternoon shifts. The outbound business represents about 57% of the total l. c. l. business.

It is interesting to note that the average l. c. l. car loading at the time this study was made was about 6½ tons, having steadily grown at the rate of about 0.1 ton per year for many years. This figure covered all outbound cars at one station. The reason for this seemingly low average is that under ordinary conditions it is common practice to make any car which has more than 6000 lb. of freight in it for one point go "straight to destination" to avoid expense and delay of handling at transfer points.

This terminal was designed by Samuel Rockwell, consulting engineer of the New York Central R.R. at Cleveland, after investigations made by him in 1912 and 1913, he having since had full charge of the carrying out of the work, in all of which the writer has assisted him. Much of the approach work and the property and municipal work has been done in conjunction with the Cleveland & Youngstown R.R., of which W. E. Pease is chief engineer.

Work on the general construction has proceeded since 1913, but preparation of plans for the buildings was not authorized until February, 1917. The structural steel work was contracted for in March and the first concrete poured in June, contracts being let as rapidly as plans could be prepared. Every effort has been made to finish the work at the earliest possible moment, and it is believed the plant will be practically completed early in May, 1918.

The Watson Engineering Co., Cleveland, has had charge of the structural, architectural and mechanical designing and supervision of construction of the buildings and bridges. The Walsh Construction Co., Davenport, Iowa, had the general contract for the railroad construction and the principal contract for the buildings.

Build Roads in National Forests

Improvements upon the national forests, which make their resources more available and their protection from fire more effective, amounted during the year to 130 miles of roads, 1153 miles of trails, 1414 miles of telephone lines, 26 miles of fire lines, 39 lookout structures for the detection of fires, 40 bridges, and 148 miles of fences, a portion of which were built in coöperation with communities, associations and individuals in the localities concerned.

What the Land Appraisers of The Delaware and Hudson Company Are Doing

Recent Sales, Assessments and Local Opinions Consulted To Determine Acreage Values Government Requires—Study Also Made of Relation of Actual Costs to Acreage Values, Both Recently and When Road Was Built

By George H. Burgess
Chairman, Valuation Committee, The Delaware and Hudson Company, Albany, N. Y.

How extensively railroad companies shall go into the appraisal of their land and rights-of-way in connection with the Federal valuation of the common carriers is optional with each company. The Division of Valuation has concluded that coöperation between the Government and railroad staffs, as in the making of the general inventory, is not desirable, and is making its investigation independently. Therefore the carriers, not permitted to check the Government's detail figures in the field, can do much or little toward verifying or preparing to dispute the net results. A large percentage of total value is involved in the land figures, and The Delaware and Hudson Company has felt that this fact warranted a thorough investigation of the many elements entering into the problem. The Division of Valuation in June, 1915, issued instructions to its land appraisers for determining normal acreage values by zones, and the company by a careful study of recent sales, assessments and local opinions has arrived at such values, which it can compare with those reported by the division. In addition its land force is carefully investigating the relation between such acreage values and the amounts a railroad company must pay for the narrow strips and irregular parcels that constitute its right-of-way, as indicated by purchases made in recent years. And a corresponding relation between original acreage values and original actual costs of right-of-way is being found by a comparison of the company's vouchers with the records of other land transactions at the time the railroad was built.

Government Calls for Acreage Values

The instructions issued in 1915 by the division of valuation to its land appraisers may be briefly stated as follows:

Appraisers are required to find the value of similar lands adjoining or adjacent to the right-of-way, and the unit of value of such lands will constitute the basis upon which to arrive at the value to be applied to the carrier's land. The appraisers are instructed to lay out zones of values, embracing in such zones so much of lands of the carrier as may fall under similar influences from adjoining lands of similar value. To find the value of a zone the present value of adjoining similar lands must be ascertained, which involves the collection of data as to sales, assessments and the ratio of assessments to present values, as indicated by recent sales and by the opinions of qualified persons residing in the vicinity of the lands in question. When the appraisers feel that the data collected as to adjoining similar lands do not throw sufficient light upon the value of a zone, they are expected to extend the investigation to adjacent similar lands.

From the above information the appraisers are expected to form an opinion as to a unit of value for each zone. It is to be noted that the above condensed instructions relate entirely to the ascertainment of a unit present value by zones of the right-of-way based upon information obtained as to value of adjacent or adjoining similar property.

It is not the purpose of this article to enter into any discussion as to the merits of the positions taken by either the division of valuation or the carriers, but to describe the methods employed in doing the work.

Company's Field Organization

The field work of the company's investigation is in charge of a land appraiser, who has assisting him an assistant land appraiser and local appraisers in each county. None of the men selected for this work had been previously in the service of the company with the exception of the land appraiser, who had done work occasionally in connection with the purchase of right-of-way, though not regularly employed for that purpose. He has had extensive experience in land matters, having for many years conducted an abstract-of-title business. In addition he at one time was clerk of one of the counties in New York State. His assistant is experienced through having been employed by the State of New York in connection with the purchase of right-of-way for its new Barge Canal, and the local appraisers are men of mature years, whose business training is such as to give them considerable experience as to land values. It is considered extremely important to select experienced men for this work, and particularly men who are familiar with property values through long residence in the locality, and who are also well acquainted with persons properly equipped to furnish opinion and information as to values.

Each appraiser is furnished with the right-of-way maps through the territory he is to cover. He then walks over the line and prepares a preliminary zone map, at the same time obtaining information as to adjacent land values by conference with such of the local people as are thought well qualified to give such opinions. After making an investigation as to sales near the railroad, he obtains further information by an investigation as to assessment ratio. In obtaining information as to assessments he is instructed to ascertain the actual considerations of all sales in each town that have been recorded in the previous three years, wherever it is possible either from the records or by personal investigation. For each sale on which a consideration has been found the appraiser investigates the assessment, and from all these sales the average of the assessment ratio is obtained for the town. This

ratio is set up against assessments of adjoining property, which furnishes additional information on the zone maps.

After the data from all these sources have been obtained a final zone map is prepared, the map being divided by distinguishing marks to indicate the limits of each zone. These zones are numbered and the supporting data shown on the various field forms bear the same numbers to identify them.

On this map is indicated in a color blocked out to show the actual area, except in very large sales, the relative location of these sales with reference to the right-of-way, and on these blocks is also shown the consideration by the price per acre or per square foot as the case may be, so that an inspection of the map readily shows all the sales that have occurred in the vicinity of the right-of-way, with the unit prices paid. A separate set of field forms, together with a supplementary sheet or sheets analyzing all the information that has been obtained, with the appraisers' conclusions as to the adjacent land value, is made for each zone set up. These forms were suggested by W. R. Camper, land attorney, Eastern group, and have been found to be extremely satisfactory for the purpose.

How Values Are Analyzed

The four forms indicated are copies of some actually filled out in the field for a certain zone, only the names being fictitious. The analysis of the unit value arrived at, as reported by the field appraiser on a blank supplementary form, is quoted as follows:

"This zone comprises property in the heart of the business section in the village of Adams. Within this zone is located the passenger and freight station, the main tracks of the railroad crossing Main St. to the north.

"About six years ago this section was swept by a large fire which destroyed all the commercial properties to the north and west. At that time there were several transfers made (as has been stated), at prices in excess of normal values in some cases.

"We show one sale of improved property and four sales of vacant land, ranging in value from 50 to 93c. per square foot. We show four opinions at from 60 to 62c. per square foot. The assessments tabulated show values from 60 to 75c. per square foot.

"In arriving at a conclusion we believe that the high value of 93c. per square foot is abnormal, as we are informed that this purchase was made to protect the rear end of a business block on Main St. from enroachment by an undesirable business. Again, the sale recorded at 50c. per square foot was for vacant land in the rear of a business block on the north side of Main St., and while it is normal in value as to location it does not represent actual values facing on the street.

"We therefore believe that the fair unit of value to be applied to this zone is that represented by the sales at 60 and 69c. per square foot. We conclude that 65c. per square foot should be our unit of values for this zone."

The investigation of the assessment ratio is considered of the utmost importance. We have not confined it to property immediately adjacent to the railroad, but have taken all sales within each town which could be properly identified and used in connection with our work; and while the work involved is considerable, the results obtained are felt to be conclusive. The State Tax Commission of New York has conducted investigations covering a period of years as to the assessment ratio of the various towns and counties of the state, and access may be had to these figures; but our independent investigation leads us to feel that the ratio as set forth by the commission is higher than is actually the case. Probably the commission's investigation has not been as thorough as ours on account of the large area embraced within the state boundaries, and possibly the commission took only the more favorable cases.

TABLE I. RATIO OF ASSESSMENT VALUES TO MARKET VALUES IN TWO COUNTRIES AS DETERMINED BY STATE TAX COMMISSION AND BY RAILROAD COMPANY'S APPRAISERS

	County A			County B	
Town	State Ratio Per Cent.	Railroad Appraisers' Ratio, Per Cent.	Town	State Ratio Per Cent.	Railroad Appraisers' Ratio, Per Cent.
A	55	39	A	55	46
B	35	30	B	55	41
C	36	28	C	55	56
D	37	28	D	45	48
E	36	27	E	52	43
F	32	31	F	64	50
G	25	16	G	73	40
H	42	33			
I	35	36			
J	30	29			
K	35	32			

Table I, relating to a county in the State of New York, shows the State Tax Commission's ratio for the various towns of this county for the years 1914 and 1915, and the ratio obtained by the independent investigation of our company's appraisers; and it will be noted that in practically every case the state's ratio is higher than that found by our company.

Multiple for Railroad Lands

From the standpoint of the carriers it is desirable that a showing should be made as to the actual cost of right-of-way purchased within recent years over and above the ordinary market value of the land. The ascertainment of the cost of the present right-of-way and lands owned by the company is in the hands of a real-estate assistant who has been temporarily assigned from the real-estate department of the company, and he and an office force assigned to him are preparing all information contained in the records of the company showing the actual cost of the property. He has access to all land and accounting records of the company, which show the amounts paid for the land.

Generally it has been found that the consideration named in the deed, particularly of earlier purchases, is the actual consideration paid. This has been substantiated by voucher records in enough cases to make it appear proper to claim as the actual cost of each parcel the consideration named in the deed, except in a comparatively few cases where such consideration is clearly erroneous. Where the records of the company are incomplete it has generally been found possible to obtain correct information from the county records showing the consideration for the purchase of right-of-way. In many cases there is charged against land an amount over and above the total of all the considerations shown in the deeds, and such amounts are set up as the costs of acquisition.

FORM V 13

VALUATION DEPARTMENT

THE DELAWARE AND HUDSON COMPANY

SALES OF ADJACENT LANDS

OWNER ____ Zone No. 5
DIVISION Washington Co Branch Map No. 15
Val. Sec. No. 2-E

STATE N.Y. COUNTY Washington MUNICIPALITY Village of Adams

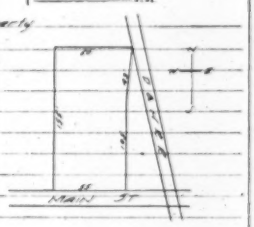
DEED May 25 1912 BOOK 165 PAGE 393 CONS. RECITED $ 6000.00
ACTUAL $ ____

GRANTOR Geo N Foster
TO
GRANTEE William Jones

EST. VALUE OF IMPROVEMENTS $ None
INDICATED LAND VALUE $ 6000.00

AREA 8664 SQ. FT. UNIT 63¢ SQ. FT.
ACRES ____ ACRE

DESCRIPTION, DIMENSIONS AND LOCATION Hotel Property
Dimensions See sketch
Located on North Side of Main St
opposite D & H Passenger Station
in Village of Adams



WAS SALE MADE UNDER NORMAL CONDITIONS? yes

REPRESENTATIVE OF VALUES IN VICINITY? Yes

ACTUAL CONSIDERATION FURNISHED BY: ____

ANALYSIS (INCLUDE TREATMENT OF IMPROVEMENTS, IF ANY; ASSESSMENT INFORMATION, AND REPORT OF FACTS):
There has been erected a business block on this lot
Assessed for 6500.00

FORM V 12

VALUATION DEPARTMENT

THE DELAWARE AND HUDSON COMPANY

LATEST ASSESSMENTS OF ADJACENT LANDS

OWNER D & H R R Co. Zone No. 5
DIVISION Washington Co Branch Map No. 15
Val. Sec. No. 2-E

(FOLLOW CAPTIONS, BUT AFTER RECORDING EACH ASSESSMENT, FILL IN ACROSS SHEET, DESIGNATION, TYPE AND USE OF LAND ASSESSED; INFORMATION AS TO BUILDINGS, METHOD OF ESTABLISHING RATIO AND ANALYSIS OF ASSESSMENTS.)

STATE N.Y. COUNTY Washington MUNICIPALITY Village Adams

OWNER	YEAR	AREA	ASSESSED VALUE	PER ACRE	PER SQUARE FOOT	ESTABLISHED RATIO	RESULTING VALUE	COST VALUE OF IMPROVEMENTS	INDICATED LAND VALUE
William Jones	9/6	850'	6500.00			70%	2885.00		
Building Estimated at 4000.00									
Land value after applying Ratio					63¢				
John Scott	9/6	3968	4500.00			70%	6428.00		
Building Estimated	4000.00								
Land value after applying Ratio					61¢				
South Block	9/6	4868	6200.00			70%	8571.00		
Building Estimated at	5000.00								
Land value after applying Ratio					60¢				
W.J. Brown	9/6	1250	2520.00			70%	3024.00		
Building Estimated	1520.00								
Land value after applying Ratio					75¢				

Above Ratio established by Board of Supervisors of Washington Co. Also by dividing total assessment value by total consideration of 45 sales throughout Town

FORM V 14

VALUATION DEPARTMENT

THE DELAWARE AND HUDSON CO.

LOCAL OPINIONS OF VALUES OF ADJACENT LANDS

OWNER D & H R R Co. Zone No. 5
DIVISION Washington Co Branch Map No. 15
Val. Sec. No. 2-E

STATE N.Y. COUNTY Washington MUNICIPALITY Village Adams

NAME Mr Henry Johnson
ADDRESS Adams N.Y. APPROXIMATE AGE 50
LENGTH OF RESIDENCE IN COMMUNITY Many years
OCCUPATION, PRESENT AND PAST Banker. County official

OTHER QUALIFICATIONS (STATE IF OWNER OR DEALER IN REAL ESTATE, AND EXTENT):
Not to any extent

BASIS AS TO QUALIFICATION OF WITNESS Good

TYPE AND LOCATION OF LAND DISCUSSED Business property in vicinity of Passenger Station on Main St in Village

OPINION AS EXPRESSED Mr Johnson says the W.J. Brown purchase (1911) was abnormal in that purchase was made to protect Main St. Block from encroachment in the rear. Also the William Jones purchase (69¢) too much. He considers the John Scott purchase (60¢) about normal

APPRAISER'S ANALYSIS OF OPINION AND REDUCTION TO SQUARE FOOT OR ACRE UNIT:
Mr Johnson is in a position to know values in this vicinity

FORM V 11

VALUATION DEPARTMENT

THE DELAWARE AND HUDSON CO.

ZONE SUMMARY OF LAND FIELD NOTES

OWNER D & H R R Co. Zone No. 5
DIVISION Wash. Co Branch Map No. 15
Val. Sec. No. 2-E

STATE N.Y. COUNTY Washington MUNICIPALITY Village of Adams

BOUNDARIES OF ZONE: DESCRIPTION AND USE OF ADJACENT LAND OF BOTH SIDES OF R.R.:
Bounded South by South line of Freight House
to North by rear line of business Block on North Side of Main St Station 1910+91.0
Bounded East by Business Block
Bounded West by Water St and Business Block

REMARKS: This zone is crossed East and West by Main St. The principal Street of the Village

SUPPORTING DATA FOR ZONE UNIT

	NUMBER RECORDED: VACANT LAND	NUMBER RECORDED: IMPROVED	RANGE: HIGH	RANGE: MIDDLE	RANGE: LOW	REMARKS
SALES	4	1	93¢	63¢ — 50¢	50¢	
OPINIONS	4		62¢		60¢	
ASSESSMENTS	4		75¢	61¢ - 62¢	60¢	INDICATED RATIO TO FULL VALUE 70%

APPRAISER'S CONCLUSION OF VALUE ADJACENT TO R/W: UNIT $ ____ PER ACRE; $ 65¢ PER SQ. FT.

George Sherrill
APPRAISER

APPRAISAL OF EQUAL AREA OF ADJACENT LAND: ____ ACRES; ____ SQ. FT. = $ ____

THESE FOUR ARE THE PRINCIPAL FORMS USED BY THE DELAWARE AND HUDSON COMPANY'S LAND APPRAISERS

TABLE II. AVERAGE MULTIPLE OF NORMAL MARKET VALUE COMPANY HAS PAID IN RECENT YEARS FOR LAND

Locality	Facility for Which Land Was Acquired	Multiple
Wilkes-Barre, Penn	Branch line	2 5
Delanson-Schenectady, N. Y	Branch line	4 06
Scranton-Carbondale, Penn	Third and fourth tracks	1 92
Binghamton, N. Y	Yard	2 41
Glenville, N. Y	Yard	3 43
Schenectady, N. Y	Terminal	2 17
Albany, N. Y	Terminal	1 5
Oneonta, N. Y	Yard	1 12
Scranton, Penn	Terminal	2 13

In the field the appraisers have been making further investigation as to purchases made by the company during the last ten years where extensive buying has been done at particular localities, and after the assessment ratio is investigated a comparison is made between the actual prices paid by the company and the ordinary market value as indicated by an application of the assessment ratio to the actual assessment of the properties at the time of purchase. By the methods indicated it has been found that the company has paid for lands in various localities above the normal market price, as shown in Table II.

A further study that has been made by this department, thus far only experimentally, is the investigation of the normal market value of land previous to the construction of the railroad, the ratio between such normal market value and the actual cost to the company of its right-of-way and a further investigation as to the normal market value after the company had constructed the railroad. For this purpose a line ten miles long, built in 1851 and 1852, was selected. A search of the records in the case of one farm from which the railroad company had bought a right-of-way showed that the railroad company paid 7.1 times as much per acre for the right-of-way as the grantee had paid for his farm previous to the construction of the railroad. A further search of the passing of the title to the remainder of the farm after the sale of the right-of-way indicated that the right-of-way cost three times the next selling price. This particular investigation clearly brings out the multiple above the normal market value which was paid by the railroad company when it purchased its right-of-way, and also the multiple which might now be applied if an estimate was made of the cost of reproducing the right-of-way.

By the use of the forms mentioned a uniform system of supporting data is preserved for use in checking the work of the Government appraisers and for such other use as may be necessary in setting up claims where differences occur. The land appraiser or his assistant are in constant touch with the local appraisers to the end that all work is being done in a uniform manner, and with this close supervision it is believed the possibility of inconsistencies in the work and results is eliminated.

Abandoned Railroad Right-of-Way as Location for Highway

The State of Pennsylvania has been offered the 43-mile abandoned right-of-way of the Delaware, Lackawanna & Western R.R. between Clark's Summit and Milford to be used as a state highway. The matter has been taken under consideration, but since the construction will cost approximately $1,250,000 it is indicated that the state will require three to five years in which to do the work.

New Machines Facilitate Track Maintenance Work

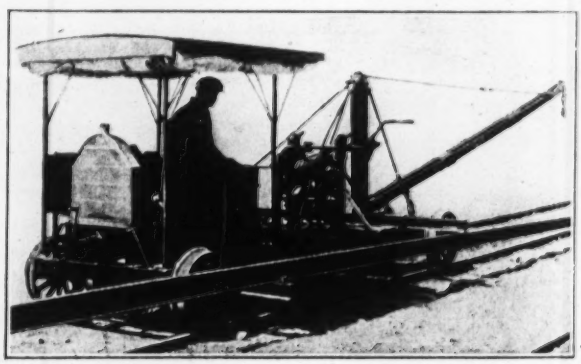
Railway Engineers Devise Apparatus to Increase Efficiency and Economy on Track Upkeep with Reduced Forces

MACHINES for railway track work have a special value at this time in view of the scarcity and high cost of labor. Three machines recently devised and put in operation have the respective functions of rail handling, rail drilling and tie sawing. These are shown in the accompanying views.

The function of the rail-laying machine is to pick up rails which have been distributed along the right-of-way and place them in the desired locations and positions in the track. Four men are required to perform the work expeditiously—one operator on the machine, two men to steady the ends of the rail which is being handled, and one man at the center to attach and detach the rail tongs. This machine will easily pick up 100 lb. rails up to 39 ft. in length and place them in position at the rate of 90 rails per hour, if necessary.

Power is furnished by a 4¼ x 5½-in. four-cylinder gasoline engine so connected that the machine can be moved in either direction at speeds varying from 4 to 16 miles per hour. The low speed is used while rails are being laid, and the high speed is used only in going to and from stations. All operating levers are manipulated from the operator's seat.

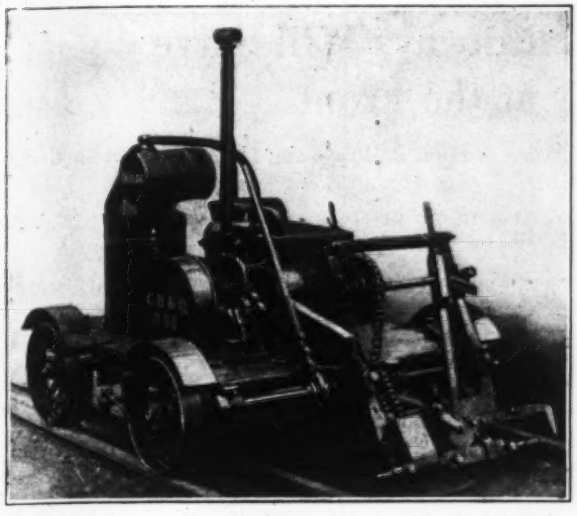
The weight of the machine complete is approximately 4500 lb. Four men can remove it from the track in less than six minutes, using a pair of specially designed trucks or dollies; these are placed underneath the frame,



THIS LIGHT DERRICK CAR REPLACES RAIL-HANDLING GANGS

allowing the machine to be swung round and run upon two planks laid at right angles with the rails. Trailer cars can be coupled on and a gang of 75 or 100 men quickly conveyed to and from the work, hand or motor cars being thus eliminated.

In addition to laying rails, the machine is used to haul and distribute extra rails, spikes and bolts when the steel gang is closing or finishing the track. It is used also as a rail loader. In this case it is placed and anchored on a flat car, and while the train is in slow motion the old rails are picked up and placed on a car ahead.



PORTABLE MACHINE DRILLS BOLT HOLES IN RAILS

Actual service and tests have proved, it is stated, that this machine is a great economizer of time. Near a station where the rails were distributed on either side of the track, and several switches which were to be placed were piled along a team track, four men with this machine distributed the rails, frogs and switches in two hours. It would have taken 15 men six hours to do this work by hand.

On June 17, 1917, a gang of 58 men with one of these machines laid 240 90-lb. rails in four hours. On June 27, 48 men with a machine laid 157 100-lb. rails in 145 minutes, the machine being delayed several times waiting for adzers. During a part of this run 60 rails were laid in 45 minutes. As to the saving of labor, when rails are laid by hand 16 men are required to handle one rail with tongs. With the machine only three men in addition to the operator are required for the same work, a saving of 12 men or 75% thus being effected.

The purpose of the tie-sawing machine is to saw or mark ties which require adzing in the track. Circular saws mark the ties on each side of the rails, being set and gaged from the top of the rail to cut at a depth corresponding to the bottom of the rail. After this operation the track is ready for the steel gang, as all obstructions such as rail braces and boulders have been removed. Upon removal of the old rail the adzmen clip out the small blocks between the cuts and the depression left in the tie by the old rail. It will be readily understood that by sawing the ties in this manner very little intelligence and effort are required to do an accurate job of adzing. It not only simplifies the task, but insures an even and uniform bearing for the tieplates.

Power is furnished by a 4½ x 5½-in. four-cylinder gasoline engine, which propels the machine at 3 to 18 miles per hour in either direction. The low speed is used while ties are being sawed and is connected synchronously, so that when the sawing is extra deep the machine slows up in accordance with the speed of the engine. The machine weighs approximately 2800 lb.

Removal from the track is facilitated by a center pivot, permanently attached underneath the car frame. After one end of the car is jacked up, a wood block is placed under the pivot and the jack is removed, after which the machine is swung at right angles to the track and pushed along two planks clear of the track.

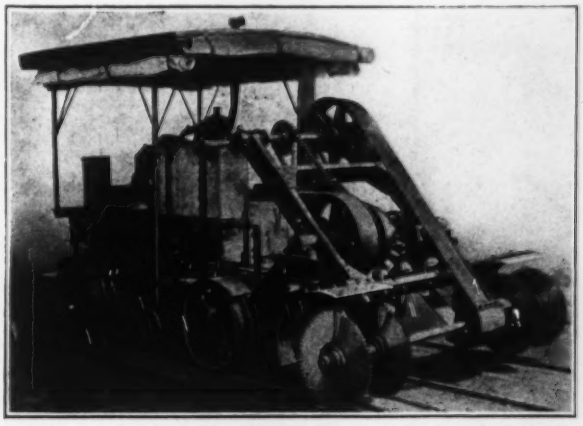
Only two men are required with this outfit—one operator to handle the machine and look after the work in general, and one assistant to walk ahead and look out for obstructions, such as rocks and rail braces. Under normal conditions from 3 to 5 miles of track are sawed per day, depending entirely on the number of trains during working hours. It has been proved that ties adzed in this manner furnish the desired uniform bearing for the tieplates, thus eliminating rail stress and breakage of tieplates and reducing the cost of labor to a minimum.

The rail-drilling machine is employed to drill holes for rail anchors and connections, superseding the hand-power track drills. Power is furnished by a 4-hp. single-cylinder four-cycle, water-cooled gasoline engine which propels the car at a speed of 18 miles per hour to and from work. The drill frame is so constructed that it can be swung in position and operated with one hand, drilling any size hole up to 1¼ in. in diameter.

Under average conditions two men are required to operate this machine successfully at its maximum efficiency—one man to handle the machine and one assistant to mark the location of holes and aid in removing the machine from the track. On main line, flagmen are necessary for protection. In some cases two of these machines are operated close together.

The average number of holes drilled with one of these machines per day is 240, three gallons of gasoline and two pints of lubricating oil being required. An automatic feed is one of the features. The drills are lubricated or cooled with water carried in a tank at the rear of the machine and conveyed to the drills by pipe and flexible tubing. The weight of this machine complete is 1140 lb. Two men can remove it from the track in less than four minutes. A drill grinder is mounted on the frame and drills are ground during waits for passing trains.

These three machines were designed by W. T. Krausch, engineer of buildings, and E. F. Weber, assistant engineer, of the Chicago, Burlington & Quincy R.R. Patents were granted in October, 1917.



SAWS CUT GROOVES IN WORN TIES TO INDICATE DEPTH OF ADZING FOR TIEPLATES

Large Mileage of Light Railways Will Serve American Troops at the Front

Department Organized for Big Construction Program—Relation of Light Railways and Highways Explained—Narrow-Gage Lines Have Been Big Factors in Relieving Congestion of Motor Trucks on Roads

By Robert K. Tomlin, Jr.
Engineering News-Record's War Correspondent in France

FOLLOWING the experience of the French and British armies, the American Expeditionary Force is preparing to construct in France a large mileage of "light railways"—60-centimeter gage—as a part of the necessary transportation system serving the troops at the front. These railways are the connecting links, to a great extent, between the railroads or termini of the standard-gage lines and the trenches and batteries. The service which the light railways render is also closely coördinated with that of the military highways.

An indication of the importance which is attached to the light railway work is gained from the fact that the director general of transportation has created a special department to have charge of the construction, maintenance and repair of these lines of communication and of the equipment used in their operation. At the head of this organization is one of the high ranking engineer officers of the American Army. Associated with him in the administrative headquarters of the department are men, all engineer officers, of the following caliber: One, in civil life, is president of an American railway; another is a vice president and general manager; a third bears the title of chief engineer of a system in the western part of the States; a fourth is assistant general superintendent of lines in the East; a fifth is master mechanic, a man with a wealth of practical experience, to whom will be entrusted the upkeep and repair of equipment in the engine terminals and machine shops which form an important part of the light railway project.

As the result of a conference with these officers, I have been given the following information regarding one of the most important phases of our military transportation problems:

Early in the war it was found that to undertake the supply of the front lines with motor trucks required such a great number of them that the highways were continually congested. It was found, too, that this excessive motor traffic soon wore the roads down to such an extent that the greater part of the motor trucks were required to haul road material to repair the damage caused by their own traffic. The light railways were developed to overcome these difficulties, and they have been so successful that it is possible now to keep the highways in repair and to devote them entirely to the use of fast-moving automobiles, motorcycles and motor trucks. In short, heavy and bulky traffic is moved on the railways; light and fast traffic on the highways.

The function of the light railways is to carry forward as near to the front as possible ammunition, forage, road material, rations, lumber, fuel and miscellaneous engineer supplies. They are also used in transporting troops, and wounded men are brought back from the front on these lines in better condition than by road ambulances. In addition, artillery trains, having guns mounted on specially constructed cars, are moved on these railways; as the position of these guns can thus be quickly changed they are not so likely to be accurately located by the enemy.

The location of light railway lines requires considerable skill. They must be located so that they are concealed from the enemy as far as possible. They should not be under direct observation, and, if located so that they do not show up in aërophotographs too prominently, the chances of their being hit by shell fire is minimized. With advantage taken of woods and rough features of the ground, lines can oftentimes be built so as to be invisible to the aëroplane. Lines must be located to follow the contour of the ground as nearly as possible, thus minimizing damage to the country and permitting the greatest rapidity in construction.

On an average, 1000 men can grade, lay and ballast a mile of track in a day. Grades are usually restricted to not more than 3 to 4%, but in some instances this is

Official French Photo
GERMAN PRISONERS MOVING LOAD OF LIGHT RAILWAY TRACK SECTIONS IN THE REGION OF THE MARNE

exceeded, and sharp curvature, 30-meter radius, is often used. The roadbed is usually 9 ft. wide on top; cuts are 14 ft. wide on the base, with side ditches, leaving a 9-ft. crown.

The track is 60-centimeter gage (23⅝ in.); the rails are generally 20 lb. to the yard, but American track will be constructed with rails weighing 25 lb. per yard, bolted to steel ties. The ties are 43 in. long, 5½ in. wide and ⅛⅜ in. thick. Wood ties 4 x 6 in. by 4 ft. 6 in., however, are used under certain conditions. The rails are received in 5-meter lengths (15.4), and the track is assembled and bolted, eight ties to a section, before being sent to the front. These sections of tracks are connected on the grade. It has been found that the track must be well ballasted, and for this purpose gravel, broken stone, broken brick, slag and cinders are used.

These lines radiate in various directions toward the front from the broad-gage railheads, so that a considerable mileage is embraced in one group or system. Oftentimes the ends of these spurs will be linked up by a connecting line which, in a general way, parallels the front-line trenches. Thus a system sometimes shows up as a series of loops; in other cases a system assumes a tree formation, with main trunk and branches.

The American equipment consists of steam locomotives of the 2-6-2 type, weighing about 17 tons, built by the Baldwin Locomotive Works, and having a tractive effort of 6200 lb. The cars are of the gondola type, about 17 ft. long and 5 ft. wide, with a capacity of 10 tons. A certain number of box, flat and tank and ambulance cars are also used. The steam locomotives operate to within a certain distance of the front—up to a point where smoke and steam would betray their presence to the enemy, after which the cars are taken still farther forward by gasoline locomotives, and final distribution of supplies to some of the most advanced points is made by motor trucks, by animal traction, occasionally by cableway or rope tramway, by pack mules and by hand. The lines are also laid into quarries where road material is obtained, and into forests where lumber and fuel are loaded directly for the front.

The hard usage to which the equipment is necessarily subjected, and the damage or destruction of equipment by shell fire, make necessary, of course, a large force of skilled mechanics, shop equipment and an abundant reserve of materials.

A great amount of crushed stone is hauled by these railways and set out on spurs alongside the highways, whence it is distributed by the road motor trucks. To appreciate fully to what extent these railways have relieved the highways, it is only necesary to remember that the average motor truck carries 3 tons, and the average light railway train of 6 cars carries 60 tons, thus doing the work of 20 trucks. From one railhead on the British front, a single line of light railway recently handled 2100 tons in a day, or 700 motor truck loads.

With a low maximum speed, an average train run of only a few miles, and such a network of tracks that only the initiated can distinguish between main lines and branches, it goes without saying that no very elaborate methods of train dispatching and signalling are required. However, it rarely pays to install double track, and the intensive use of single track lines, together with the frequent interruptions to traffic in forward areas due to enemy shell fire, make the personal equation in dispatching of great importance. Rules are necessarily few and simple. Both British and French methods of operation reflect to some extent their broadgage practice, and similarly employees of Amercian military railroads find their work simplified by rules which follow certain rudimentary principles of American Railway Association practice. A simple form of telephone train dispatching, combined with a modified block system, has been found most practicable. While every effort is made to operate without waste, the primary object of the light railways is to meet the needs of the armies in the field, and no questions of economy are permitted to interfere with regularity and reliability of service.

The orders placed in the United States for locomotives, both steam and gas, cars and track material, some of which have already been received in France, indicate

Official French Photo

ONE OF THE GASOLINE LOCOMOTIVES USED ON LIGHT RAILWAYS NEAR FRONT—NOTE SECTIONS OF TRACK PILED IN BACKGROUND

that the U. S. Army will be provided with as many thoroughly equipped miles of light railway as it can use.

The sections of light railway track are transported to the work in various ways—sometimes on standard-gage cars, sometimes on motor trucks, sometimes along existing light railway track, or by a combination of any or all of these transportation facilities. At the main yards cranes, where available, will be used for loading the sections of track for transport, but in the actual construction of these narrow-gage lines no plant is required. In fact, this need for nothing but manual labor is one of the features which make the light railways so admirably adapted for work in the field of enemy observation and fire. In one sector where artillery operations were active, I am told, a single line of light railway was broken and repaired 95 times in one day.

In some areas which have been heavily shelled it is necessary to advance lines of light railway over "rights-of-way" which are literally pockmarked by craters ranging in size from slight depressions to deep, wide gullies. Here the needs of the moment determine the methods of procedure. If a large labor force is available the pits are filled in and roughly graded. When the work can be done more quickly by carrying the lines across the craters on timber grillages this form of construction is employed—provided timber is available. It is situations such as these that bring out the resourcefulness of the engineer. His job is to advance the lines or to repair a broken section, and any method which accomplishes this end, and accomplishes it with *speed*, is acceptable.

In a preceding paragraph reference was made to the use of both steel and wood ties for supporting the light railways. Steel ties will be the prevailing type, but the wood ties will be employed where a large bearing area is needed, as, for example, where the ground is soft or where the curvature is sharp. Sometimes, of course, stone ballast may be scarce, and here again the wood tie, with a bearing area greater than that of the steel tie, will serve a useful purpose.

As for the ballast, the intention is to secure most of it from quarries operated by the Department of Roads (highways), but a limited supply is obtainable from the shattered remains of brick and stone buildings in the devasted areas. Whole brick, however, are exceedingly valuable in France at present, and use of this material is permitted on the basis of culling out the whole brick from the débris and carrying away only the bats for railway ballast purposes. The Department of Light Railways will work in close coöperation with the manager of roads in this matter of the production and transportation of crushed stone.

Official French Photo

THE LIGHT RAILWAY IS USED EXTENSIVELY TO DELIVER ROCK FOR ROAD CONSTRUCTION

The location of the light railway lines involves also some topographical surveying work, and parties are now collecting the data from which contour maps are being prepared. Officers have been out over the territory where it is probable that our network of light railways will be built and have done a great deal of rough reconnaissance work as a preliminary to actual construction.

The man who visits the headquarters of the Department of Light Railways and talks to the engineer officers who are directing its activities, as I have done, is impressed at once by their enthusiasm for the work in hand. Their experience on standard-gage lines back in

the States, an invaluable asset over here, is being diverted into new channels of usefulness, and there is in the planning and execution of the light-railway project for war service enough of novelty to take it out of the class of routine and make it a new and intensely interesting job. And yet the satisfaction which these engineers are getting in the performance of the duties to which they have been assigned is not that, if I interpret signs correctly, of the man who merely solves some technical problem. There is more to it. These little railway lines—almost toy railroads in appearance—will form a great steel web over the American sectors, and on the integrity of its double bands of steel will depend, in large measure, the effectiveness of the fight we are to wage and the speedy transport of our wounded to the rear. Here is work, therefore, that calls for the best there is in the engineer, and that best is being given freely.

Precast Bridge Slabs of Concrete Incased I-Beams

Chicago & North Western Railway Uses New Type of Overcrossing with Heavy I-Beams, and Openings in Concrete To Save Weight

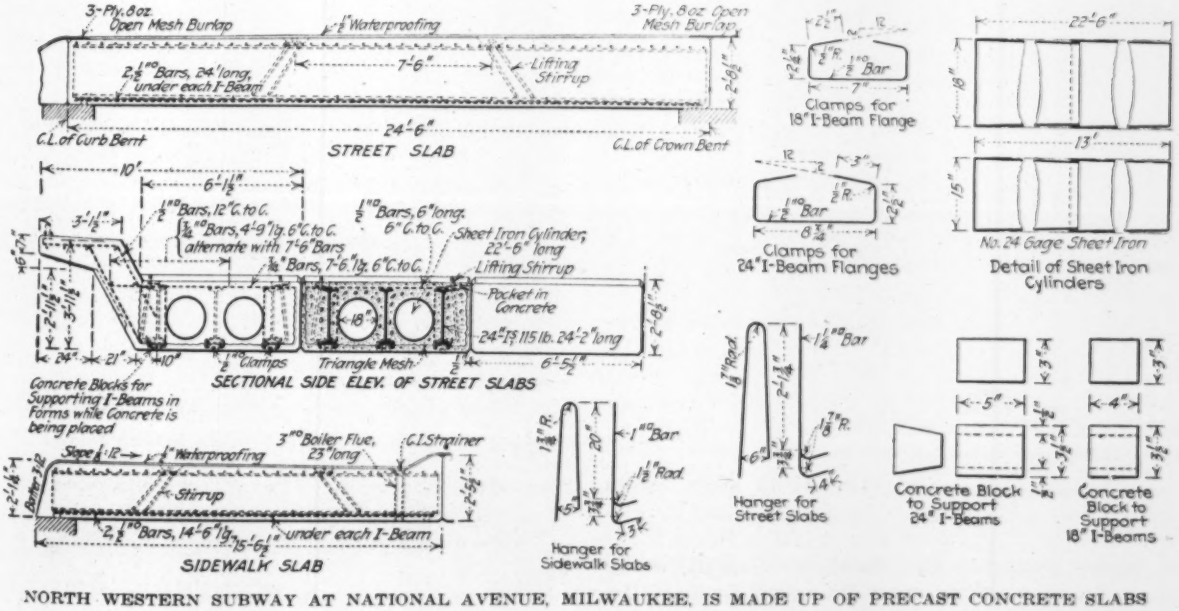
SLAB-DECK construction of a new type for the spans of concrete subway bridges on track-elevation work has been employed recently at Milwaukee and Chicago by the Chicago & North Western Ry. It consists essentially of slab spans having I-beams which carry the load and are incased in concrete, which is not considered as carrying any load and can therefore be reduced in weight by forming hollow spaces within it. The concrete combines the functions of bracing the I-beams, protecting them from corrosion, and forming a solid floor. This type of slab-span deck was devised by the railway company's engineers, and was used for the first time on the Milwaukee track elevation in 1916.

The hollow slabs do not form reinforced-concrete spans, since the concrete is mainly a filler and not the load-carrying element. Minimum depth of floor is an important consideration in the design of structures of this kind, and reinforced-concrete slabs would have been of greater thickness or with heavy reinforcement to obtain equal strength in the same thickness as that of the I-beam slabs. They would have been of much greater weight, since they would necessarily be made solid.

Preliminary studies were made of alternative designs for concrete bents carrying a slab deck, and steel bents carrying a steel-trough deck. The former was adopted, as it combined greater permanence with lower cost for both construction and maintenance. The I-beam and concrete combination was preferred, even at an increased cost of about 5% for material as compared with reinforced concrete. The preference was based on certainty of action of steel beams under track loads, facility of construction of the slabs, and 25% lighter weight of slab due to the hollow spaces.

Typical construction of the subways comprises two roadway spans and two sidewalk spans, supported on three bents and two abutments of reinforced concrete. Slabs for the roadway spans are 24 ft. 6 in. x 6 ft. 5½ in., with a depth of 32½ in. over the central bent and 29½ in. over the sidewalk bent. Each has three 24-in. 115-lb. I-beams. These roadway slabs weigh about 26 tons each.

Upon the top flanges of the I-beams are laid transverse rods, while under each beam are two longitudinal rods held by clamps or hangers fitted to the bottom flanges. In addition, there is a sheet of triangle-mesh wire netting in the bottom of the slab and extending up both sides. The rods and netting are provided to


3-Ply, 8 oz. Open Mesh Burlap
½" Waterproofing
3-Ply, 8 oz. Open Mesh Burlap
2, 1" Bars, 24' long, under each I-Beam
7'-6"
Lifting Stirrup
24'-6"
C.L. of Curb Bent
STREET SLAB
C.L. of Crown Bent
Clamps for 18" I-Beam Flange
Clamps for 24" I-Beam Flanges
No. 24 Gage Sheet Iron
Detail of Sheet Iron Cylinders
SECTIONAL SIDE ELEV. OF STREET SLABS
Concrete Blocks for Supporting I-Beams in Forms while Concrete is being placed
Pocket in Concrete
Triangle Mesh
Hanger for Street Slabs
Concrete Block to Support 24" I-Beams
Concrete Block to Support 18" I-Beams
Slope ¼:12
1" Waterproofing
3" Boiler Flue, 23" long
C.I. Strainer
Stirrup
2, 1" Bars, 14'-6" lg., under each I-Beam
SIDEWALK SLAB
Hanger for Sidewalk Slabs

NORTH WESTERN SUBWAY AT NATIONAL AVENUE, MILWAUKEE, IS MADE UP OF PRECAST CONCRETE SLABS

PORTAL OF CONCRETE SUBWAY HAS INCLINED FACE AND CANTILEVER FOOTWALK

strengthen the concrete against stresses in the handling of the slabs and to resist temperature stresses. Slabs for the sidewalk spans are of similar construction but of less thickness. The end over the bent, however, has a narrow shoulder of the same thickness as the adjacent roadway slab in order to provide a sloping surface for the waterproofing course and to avoid an abrupt change of shape.

Every slab has four steeply inclined U-bar stirrups for lifting, these being embedded in the concrete and anchored to the I-beams. Their loop ends do not project above the surface, but are in pockets which are filled with concrete after the slabs are placed, so as to give an even surface for the waterproofing.

Cantilever projections on the outer sides of the facia or portal slabs form walks for railway employees. The exposed faces of these slabs are inclined. Recessed panels, together with the broad projecting top shelf or cornice, help to give a good appearance to the street front of the structure. No surface treatment of the concrete is given to the exposed faces after the removal of the slabs from the forms. Hand-railing of iron pipe is placed along the edge of the walk.

Company forces made the slabs at a material yard about ½ mile from the work. Portable wooden forms were used, placed on a substantial platform. The bottom of the form was coated with a colorless oil. Tapered concrete blocks supported the I-beams at the proper height, and these remained embedded in the slab. Collapsible telescopic cylinders of sheet iron were used to form the two openings in the concrete.

Concreting was done from a train consisting of a flat car carrying a Smith mixer and having material cars coupled behind it. This plant operated on a track laid alongside the casting platform and a gang of about 25 men could pour eight to 10 slabs per day. The concrete was a 1:2:3 mix, using torpedo sand and 1-in. crushed limestone free from dust. For the Chicago work the casting platform is of concrete and forms the bottom of the slab forms. This gives a smoother finish to the bottom of the slab, and is not affected by exposure when not in use.

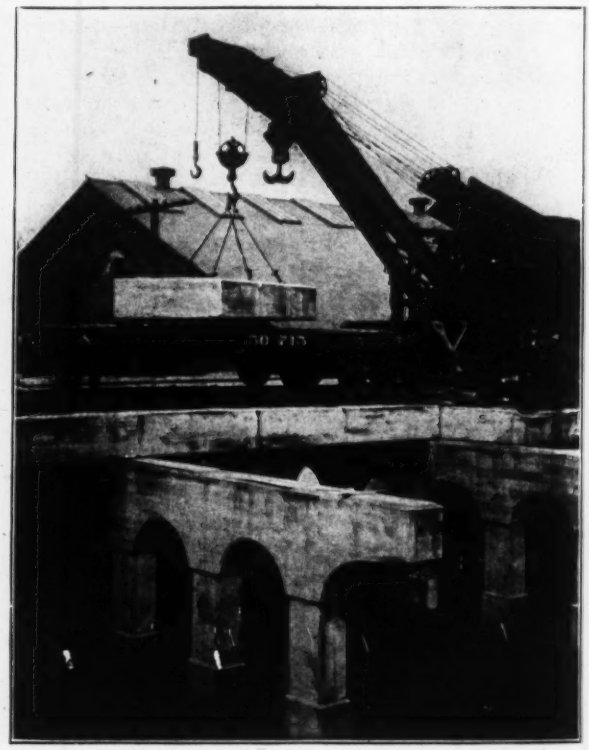
Curing the slabs for a period of 72 hours before moving them from the platform was sufficient in ordinary weather. They were then stacked in the yard for 12 days. This time was found to be ample, owing to the use of a quick-setting cement, while the cylindrical openings in the concrete seem to hasten the curing by affording ventilation to the interior of the mass.

When required for erection, slabs that had been given sufficient time for curing were loaded on flat cars and taken to the work. There they were picked up by a 100-ton wrecking crane, having wire-rope slings hung to the hook of the hoisting block and attached to the four stirrups of the slab. The ends of adjacent slabs were laid in close contact, but ½-in. longitudinal openings were left between the sides of the slabs. These openings are calked with oakum and filled with mastic.

Before the slab is seated, a ⅜-in. bed of neat cement mortar is spread on top of the bent and covered with a strip of zinc of No. 22 gage. At the abutments, the slabs rest directly upon the bed of cement mortar.

Waterproofing the decks is of special importance, to avoid dampness and dripping in the subway. The tops of the slabs are thoroughly cleaned and given a primer coat, followed by a coat of liquid asphalt. Then a three-ply burlap mat, applied with hot asphalt, is spread over the entire surface and carried down the backs of the abutments far enough to cover the horizontal bridge-seat joint. Upon this is a single layer of asphalt-felt, to protect the burlap from burning under the next application, which is mastic of one part asphalt to four parts sand, in two ¾-in. courses.

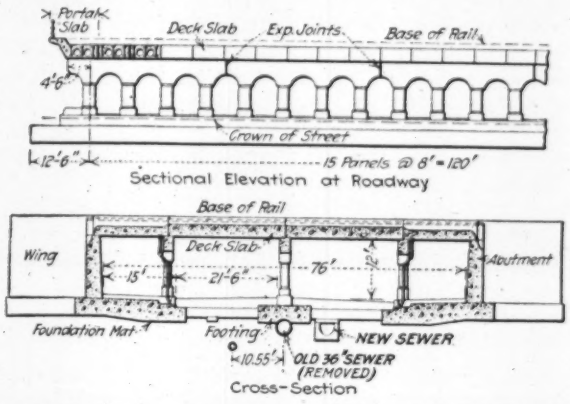
After the mastic has been worked with hot smoothing irons and floats, a coating of hot asphalt is applied with swabs. When this is hard, the entire surface is covered with a 1½-in. cement-mortar protection coat reinforced with galvanized-iron netting of 1-in. mesh. Stone ballast is spread upon this and is 6 in. deep under the ties.



WRECKING CRANE PLACES DECK SLABS—NOTE ZINC BEARING PLATES ON CAP GIRDER

The waterproofing primer and liquid asphalt coat are applied to the backs of abutments and wing walls, with two-ply burlap over the vertical construction joints.

Reinforced-concrete bents at the curb lines and center of the street support the slab deck. These have rectangular columns 20 x 32 in., spaced 8-ft. centers. The columns are poured integrally with the cap girder, which is shaped to form arches between the columns, and is 20 x 36 in. at the crown of the arches. This girder is in 32-ft. lengths, with ½-in. felt fillers in the



CONCRETE DECK SLABS HAVE I-BEAMS TO CARRY LOAD

expansion joints between them. The cantilever half-arches at these joints and at the ends of the bents have additional reinforcement.

Abutments are of the counterfort type, with a pocket behind the bridge seat so as to carry the waterproofing over the joint between the slab and the abutment. A layer of tar-paper is placed to cover the bridge seat and the back of the pocket, and a tile drain is laid on the bottom of this pocket.

Foundations of the subway bridges in Milwaukee consist of spread footings on piles. A heavy footing carries the central bent. At each side of the street is a broad slab or mat of concrete directly under the sidewalk and of such width as to carry both the abutment and the curb bent. Concrete for the bents and abutments is the same as that for the deck slabs. For the footings, a 1:2½:5 mix is used.

Long spliced piles support the concrete foundations. This part of Milwaukee was originally swampy ground and test borings indicate that it has been filled with 20 to 30 ft. of débris and cinders. The spongy and quaking soil has no supporting value, and it was necessary to drive piles to a depth of 90 ft. below street grade to reach a substratum affording sufficient resistance. Hardwood piles in 30-ft. and 35-ft. lengths were spliced with wrought-iron pipe sleeves about 2 ft. long. The load per pile is from 28,000 to 32,000 pounds.

Large foundation area was necessary to contain the requisite number of piles. To secure effective distribution of the loads a heavy foundation slab is used and is well reinforced for the pile reactions. As noted above, the side slabs are of such size that the entire sidewalk section acts as one unit, comprising the slab, abutment and curb bent.

Live-load assumed in the design of the deck is Cooper's class E-55, or a concentrated load of 66,000 lb. on each of two axles spaced 6 ft. c. to c. Impact is provided for by the formula $L \times L \div (L \times D)$, in which L and D are the live-load and dead-load stresses respectively. Maximum unit stresses are as follows: Structural steel, bending, 16,000 lb. per sq.in. Reinforcing steel, tension, 12,000 lb. Concrete, compression, 660 lb. The calculations for the I-beams make no allowance for the effect of concrete bond.

For the columns of the bents, the compression is taken as 700 lb. per sq.in. of concrete within the hooping, and 10,500 lb. for the steel. For the girders, the allowance for concrete compression is 500 lb. The reinforcing steel in the girders is taken at 12,000 lb. for tension, with compression 15 times the stress developed in concrete of equal distance to the neutral axis. This is based on the assumption that the elastic modulus of the steel will approximate 15 times that of the concrete. The abutments are designed to resist a liquid pressure of 45 lb. per cubic foot.

Construction of the subways at Milwaukee was facilitated by the fact that they were of considerable length and extended under freight yards as well as the main line. This made it possible to close four or five tracks at one time, giving room to build a section of abutments and bents and to place the deck. As each section was completed, tracks were laid upon it and turned over to the traffic department. Adjacent tracks were then abandoned, and construction was commenced on the next section.

Track elevation in both these cases was carried on entirely by the railway company's forces. All design and construction work was under the direction of W. H. Finley, chief engineer of the Chicago & North Western Ry. J. S. Pole was engineer in charge of the work both at Milwaukee and Chicago.

Sewage Sludge To Be Utilized

Drying Beds at Canton Sewage-Works Will Be Cleaned by Contractor and Sludge Disposed of Without Cost to City

By R. Winthrop Pratt
Consulting Engineer, Cleveland, Ohio

A CONTRACT for cleaning the sludge-drying beds of the sewage-works of Canton, Ohio, and for sludge disposal, both without expense to the city, will go into effect on May 1, 1918. The contractor expects to utilize the sludge in the manufacture of commercial fertilizer.

The Canton sewage-works were put in partial use in 1915 and in full use late in 1916, having been designed by the author. They have a daily capacity of about 6,000,000 gal. and consist of coarse screens, Imhoff tanks and contact beds.

Immediately adjacent to the tanks on the north are six sludge-drying beds having a total area of one-half acre. Three of the beds are covered by a glass roof of the greenhouse type. It has been found possible to dry the sludge on the covered beds during nearly all times of the year, although the uncovered beds can be used to advantage only for four or five months. Up to the present time the dried sludge, on being removed from the beds, has been dumped on low ground near the plant and considerable quantities have been hauled away by persons interested in its use as a fertilizer.

Not far from the plant and having direct rail connection thereto is an agricultural lime plant operated under the direction of H. V. Briggle, Canton, representing the O. C. Barber Allied Industries Co. During 1917 Mr. Briggle hauled away several carloads of dried sludge and treated it with lime, and possibly with other materials, in order to make a commercial fertilizer.

Recently the City of Canton and Mr. Briggle entered into a contract which contains the following basic provisions:

(1) The contractor is given the exclusive right and privilege for a period of 25 years from May 1, 1916, to remove sludge from the sludge beds and load it on railroad cars on the siding at plant.

(2) The contractor, upon written approval from the director of public service, can modify the city's present equipment for handling the sludge to suit his needs, such equipment, after installation, to become the property of the city. All other buildings and machinery which may be located at the sewage plant, however, shall remain the property of the contractor unless the city takes over the contract in accordance with the provisions thereof below mentioned.

(3) The contractor is obliged to remove all sludge from the sludge beds when the moisture of same has been reduced to 25% ; and he may, at his option, remove sludge containing a higher percentage. All methods of sludge removal are to be satisfactory to the city from a sanitary standpoint.

(4) The contract may be cancelled at any time upon sixty days' notice by the contractor that business is unprofitable, in which case the city shall exercise the option relative to the purchase, at an appraised value, of such buildings and machinery as the contractor may have erected at the plant.

(5) The city, on the other hand, has the right and privilege, upon 60 days' notice, to purchase the buildings, machinery and business of contractor at any appraised value, plus 10%.

Although the contract is not entirely binding, the contractor proposes to go to a considerable expenditure for machinery and equipment on the strength of his conviction, following his large-scale experiments as well as his general experience in the fertilizer business, that a salable product can be manufactured from all dried Imhoff sludge.

From the city's standpoint the carrying out of the proposed contract means that its expense in sludge disposal will amount simply to the labor of opening and closing the gates between the Imhoff tanks and sludge-drying beds as the sludge flows to the latter by gravity. It will be noted that the expense of removing the sludge from the beds, an item of considerable importance at the present time, is to be borne by the contractor.

Pennsylvania Builds Large Gravity Yard at Indianapolis

Development at Hawthorne Designed for Immediate Capacity of 3500 Cars and Ultimate Capacity of 10,000 Cars—Has Two Double-Track Humps

AN IMMEDIATE capacity of 3500 cars and an ultimate capacity of 10,000 cars are provided in the new Hawthorne yard of the Pennsylvania Lines West of Pittsburgh, on the outskirts of Indianapolis. The yard has two double-track humps for gravity classification of traffic in opposite directions. The improvement was authorized in 1916 to relieve the congestion in the older yard near the center of the city and provide better facilities for the increasing traffic.

The yard is located in the southeast section of the city, with a 2½-mile double-track connection from its eastern end to the main line, while the west end has a double-track wye connecting with the belt line of the Indianapolis Union Ry. Track capacity for 10,000 cars is provided in the general plan. The present construction has about 52 miles of track, giving a daily capacity for about 3500 cars, classified and passed through the yard. Land has been obtained sufficient for the full development, with a total of about 100 miles of track, which will increase the working capacity to about 10,000 cars daily. At present there are about 50 trains per day, and the yard service is performed by five switching engines.

Three units compose the general layout. One consists of a westbound receiving yard, followed by a switching hump and classification yard. The second is similar to and parallel with this, but with the positions reversed so as to serve eastbound movements. The third comprises the engine house, car-repair yard and other facilities for locomotive and car service. The first two units are separated by two running or thoroughfare tracks extending from end to end of the yard. Separate departure yards were not considered desirable, but certain tracks of the classification yard may be set aside for trains made up and ready for road engines.

For westbound traffic the receiving yard has capacity for 680 cars on eight tracks holding 75 to 100 cars each, and the classification yard will hold 1195 cars on 20 tracks for 45 to 85 cars each. For eastbound traffic, the receiving yard will hold 360 cars on five tracks for 70 to 80 cars each, and the classification yard has capacity for 1160 cars on 17 tracks for 55 to 90 cars each. In figuring the capacity of tracks 45 ft. is allowed for each car.

The body tracks are spaced 13 ft. on centers. Ladder tracks are spaced on 20-ft. centers to provide safe clearance at switchstands and passageway for switchmen. The spacing at thoroughfare tracks is 13 ft. Turnouts from the ladders are on a No. 7 ladder angle. They have 18-ft. switch rails and No. 8 frogs, with a 12° curve behind the frog. At the departure ends of the classification tracks, however, the ladder angle is No. 8. Here the turnouts have No. 10 frogs, with a 7½° curve behind the frog. The yard is laid with 85-lb. rails, with the exception of 100-lb. rails for the running tracks.

The grade layout through the yards is shown in the profile and in the accompanying table. At the west end there is a continuous rising grade eastward, owing to the slope of the land. At the east end the yards are

below the main-track level, the elevation being lowered in order to give sufficient grade for dropping cars from the hump into the eastbound classification yard. To get the required elevation it was necessary to lower Bean Creek 3 ft. where it crosses the yard.

As first designed and built the hump grades were tentative, being subject to change to meet conditions which might develop in operation. Such changes are usually necessary after new switching humps have been put in service, since average weight and style of car, prevailing winds and other local conditions affect the operation or the free movement of the cars by gravity. The present arrangement of grades, which is shown in the table and in the accompanying profile, was arrived

GRADES THROUGH HAWTHORNE YARD

	Eastbound	Westbound
Receiving yard	—0.22% for 2,000 ft. Level for 2,515 ft.	+1% for 715 ft. +0.4% for 3235 ft.
Hump approach	+1% for 585 ft. +3% for 125 ft. 50-ft. vertical curve	+1% for 800 ft. +3% for 180 ft. 50-ft. vertical curve
Hump starting	—5% for 100 ft. —3% for 100 ft.	—3% for 160 ft.
Hump ladders	—1.25% for 650 ft. —1% for 530 ft.	—1.25% for 750 ft.
Classification yard	—0.3% for 2,865 ft. —0.8% for 1,050 ft.	—0.3% for 1100 ft. Level 1400 ft. +0.5% for 1500 ft. +0.7% for 300 ft.

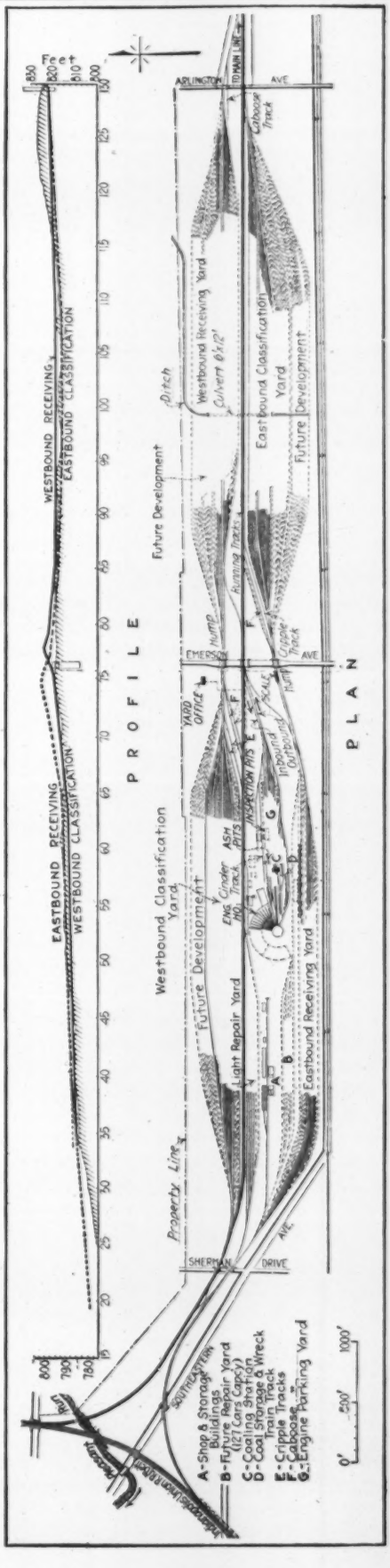
at partly by tests and partly by experience with other yards having similar traffic conditions. Less fall is given the eastbound hump track, as there is a larger proportion of loaded cars in eastbound than in westbound trains.

Two switching tracks are provided on each hump. One of these is used only for cars which have to be weighed, and on it is gantleted a short scale track. The grade over the scale, is 0.8%. The other track over the hump is used only for cars which do not have to be weighed. Weighing is required for only about 3% of the eastbound and 1% of the westbound cars.

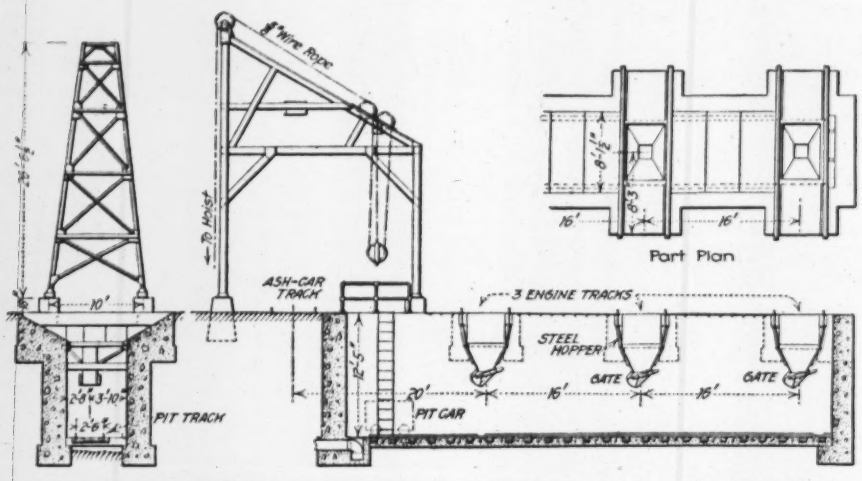
An electro-pneumatic plant for operating the switches of the classification tracks is a part of the design, the switches being thus controlled from a tower at the summit of each hump. This installation has been postponed on account of market conditions, and at present the switches are operated by hand. The car riders have to walk back from the classification tracks to the hump, but motor cars have been ordered and will operate a shuttle service for the accommodation of these men.

Electric lighting is provided, the lamps being placed through the body of each yard and along the ladder tracks. The lamps are spaced about 300 ft. apart. Compressed-air pipe lines will be installed along the departure tracks to provide for testing the brakes of trains before the road engines are attached. A mechanical interlocking plant has been installed at the connection of the east end of the yard with the main line. An electric interlocking plant is to be provided later at the Y-connection to the Belt railroad.

The engine-terminal facilities include a 10-stall roundhouse with provision for enlargement to 20 stalls. This will be 112 ft. wide, with reinforced-concrete walls, roof and floor. An annular space 100 ft. wide will separate it from an electrically operated turntable 100 ft. in diameter. In addition to the roundhouse accommodation there will be a parking yard with capacity for 25 locomotives waiting to be assigned to service.



PLAN AND PROFILE OF NEW HAWTHORNE YARD AT INDIANAPOLIS, FOR THE PENNSYLVANIA LINES—IMMEDIATE CAPACITY OF 3500 CARS, ULTIMATE CAPACITY OF 10,000 CARS PROVIDED



ASH-HANDLING SYSTEM INCLUDES SMALL PIT CARS AND AIR-HOIST ELEVATOR

A coaling station of reinforced-concrete has a track pit and 500-ton storage bin served by a conveyor of the endless chain type. The water station includes a water-softening plant and two 50,000-gal. wood tanks serving five penstocks or water cranes. Engines have their fires cleaned over a concrete ash pit of the hopper type. The ashes are discharged into small steel cars running on a track along the bottom of the pit. This extends to an air-hoist elevator which raises the cars and dumps the ashes into freight cars for removal. This is shown in one of the drawings.

A pair of tracks near the foot of each hump provides for the accommodation of 52 caboose cars. For the light repair work there is a car-repair yard which will hold 175 cars. This has four tracks in pairs, spaced alternately 22 and 18 ft. on centers. Provision is made for future increase to 12 pairs of tracks with a total capacity of 382 cars. Other special tracks will provide for the accommodation of crippled or damaged cars, for refrigerator cars taking ice and for the division wrecking train. Contracts already let include the round-house, turntable, coaling station, sand, oil and power houses, and a 2½-story brick yard office. The railway company has under construction with its own forces the water station, ash pits and icing station.

Bridge work required in the construction of the yard includes a double-track 48-ft. concrete arch over Pleasant Run, a double-track trough-floor steel bridge over Southeastern Ave., and a half-through girder bridge over the Cincinnati, Indianapolis & Western Ry.—this last made necessary by the raising of the track of the other railroad about 5 ft. to allow for the Pennsylvania crossing. A 6 x 12-ft. reinforced-concrete culvert box 600 ft. long carries Bean Creek under the yard. There have also been constructed five reinforced-concrete subways, three of which carry the yard tracks across Emerson Ave., the other two carrying the north and south Y-tracks across Sherman Drive. A reinforced-concrete viaduct 300 ft. long carries Arlington Ave. over the yard.

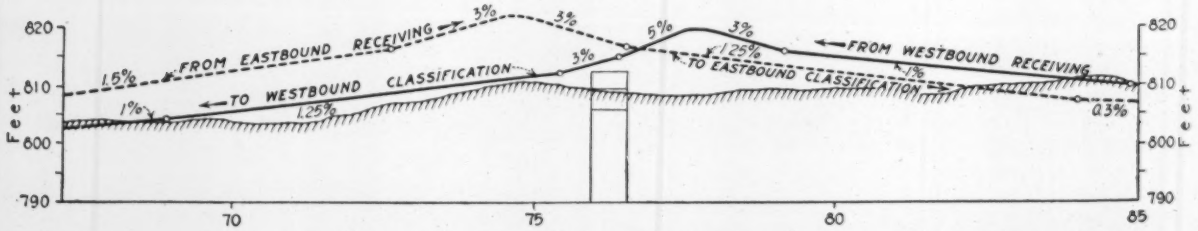
The construction work includes 350,000 cu.yd. of grading, 20,000 cu.yd. of concrete, and 17,500 sq.yd. of paving. The contractors for grading are the Dunn & McCarthy Co. and the Clifford Construction Co. Other contractors are the Roberts & Schaefer Co. for the coaling station; the Alliance Construction Co. for the round-house, oil house, sand house and power station; Latham & Walters for the yard office, and I. R. Meade for the turntable pit. All track work is done by company forces.

The design of this large gravity switching yard was prepared under the direction of W. C. Cushing, chief engineer maintenance of way of the Pennsylvania Lines West of Pittsburgh, Southwest System. Construction is in charge of D. P. Beach, division engineer, and J. H. Shilling.

Shrinking Gumbo Cracked Asphalt

In order to protect the curb and sidewalks from the destructive effect of the wheels of heavy dump wagons which were used in making a neighboring fill, California gumbo was laid over them from the center of the street to the property line in San Pedro, Cal., about three years ago. When, after about three months, the use for this temporary covering had vanished, large cracks had developed, as is customary with this type of soil.

These cracks did not stop at the surface of the asphalt pavement, but ran down through the surface and binder, and had actually torn them from the concrete base, according to D. C. Peet, formerly of the Gilmore-Wilton Co. of Los Angeles. In every case the crack through the asphalt was a continuation of that in the gumbo, and indicated that the adhesion between gumbo and asphalt was greater than that between the binder and the concrete base plus the tensile strength of the asphalt itself.



ENLARGED PROFILES OF HUMPS—GRADES WERE DETERMINED BY TESTS AND EXPERIENCE ELSEWHERE

Action of Railway Track Studied by Tests of Depression and Rail Stress

Special Committee Finds Track Acts as Continuous Elastic Support—Rigid Construction and Thorough Tamping Reduce Rail Stress—Large Increase Produced by High Speed

DEFINITE knowledge concerning the action of railway track, about which little has been known heretofore, is furnished by a series of experiments conducted by the track-stress committee of the American Society of Civil Engineers and the American Railway Engineering Association, which has just presented its first extensive progress report. The tests show that rail stresses are reduced by solid and rigid roadbed construction, by deep ballast, by heavy rail and by thorough tamping. Thousands of measurements of track depression and rail stresses were made, under both standing and moving loads. As a whole they demonstrate that railway track is an elastic structure, acting in accordance with Hooke's law and thus susceptible to exact engineering treatment. More specifically, various practical facts were brought out, among them the following:

1. The span between ties does not govern the stresses in the rail, these being determined by the general track depression (see for example Figs. 4, 5 and 6).

2. Both rail stress and track depression increase in direct proportion to the load (Fig. 9).

3. Both rail stress and depression are least for well-ballasted roadbed and greatest for poor roadbed (Fig. 7); stone ballast is better than cinders and deep ballast better than shallow ballast. Thorough tamping reduces deflections and stresses.

4. Rail stresses are less in heavy rail than in light rail, as brought out by the curves of Fig. 10.

5. A train produces higher rail stresses at high speed than at low speed (Fig. 8); the increase may exceed 50 per cent.

6. The stress in the outer flange of the rail generally is much larger than that in the inner flange. The rail is subjected to a certain amount of transverse bending.

Auxiliary to the tests was the development of a new and highly precise form of recording extensometer for rail stresses, and of other instruments and test methods which proved successful in overcoming the formidable difficulties of the problem.

The committee realized these difficulties, but "felt that an adequate report on stresses in railroad track must be based on experimental data derived from extensive tests on standard track. . . . The anticipated difficulties were not overestimated. . . . The tests have involved the making, reading, recording and reducing of more than 250,000 observations on rail strains alone." Each point plotted in the stress diagrams of Fig. 8 represents about 100 records taken on stremmatograph disks, so that the whole diagram for a particular locomotive at speeds from 5 to 60 miles is made up from several hundred stremmatograph records and several thousand readings of these records. The work was begun less than four years ago.

Roadbeds of various kinds were used for the tests. Several stretches of track were prepared by placing ballast to predetermined depths, putting in new ties, etc., but track not specially prepared was also tested. The effect of decayed ties and low spots in track was studied. The rail in the test sections ranged from 85 to 125 lb. per yard. The ties were generally 6 x 8 in. x 8 ft., but ranged up to 7 x 9 in. x 8½ ft. The depths of ballast varied from 6 in. to 24 in. under the tie.

Measurements were made under static loads and moving trains. The static loads included (1) a single load per rail (2) two loads per rail, arranged to represent two axles of a car, and (3) locomotives of different types. The single and double loads were applied by load-indicating screw-jacks bearing on the top of the rail and reacting against a load of iron on a flat-car standing over the test section. The tests under moving load were made with locomotives having driving-axle weights of 23,000 to 33,000 lb. Speeds from 5 to over 60 miles per hour were employed. In each case the locomotive was run over the test section with steam shut off, after a flying start.

Besides the load-indicating jacks the instruments included level bars to measure track depression under static load, a photographic camera to measure depression under moving load, Berry strain gages of 4-in. gage length for the static stress measurements, and recording extensometers or stremmatographs for the moving-load tests.

Depressions under static load were measured by a level of sensibility 20 in. per division, mounted on a bar fitted with a vertical micrometer screw at one end. One end of the bar being placed on a fixed reference stake and the other on the rail base (Fig. 1), the micrometer gave the difference of level between stake and rail; by taking readings without load and with load, the depression was obtained. No results secured with the photographic device are reported.

The stremmatograph designed for the moving-load tests is an autographic extensometer of 4-in. gage length, recording without lever magnification by a steel phonograph needle scribing on a smoked glass disk (Fig. 2). A flat steel-spring section in the pen bar connecting the two rail clamps gives uniform pressure free from chatter. The stremmatograph was attached to the base of the rail and the disks were rotated by gearing actuated by a long shaft extending away from the track, turned by hand. The records were measured under a microscope magnifying 75 diameters. Usually four stremmatographs were placed in a group, three on one rail and one on the opposite rail; three adjacent set-ups of this kind were made before a single test was considered complete (Fig. 3).

The stremmatograph as originally built had only one pen bar and record disk, giving the stress in the outer flange of the rail base, in the usual setting of the instrument. Before this had been in use very long, certain irregularities led to the discovery of marked differ-

ence in stress between the two flanges; the instruments were then fitted with record disks on both sides. The diagram in the lower right-hand portion of Fig. 8 shows separately the stresses in the inner and the outer flange under a moving locomotive. There are large differences between the curves, changing with change of speed. This particular diagram was made on cinder-ballasted track; in diagrams made on stone-ballasted track the stress difference between the inner and outer flange does not change materially with speed.

Typical depression curves (only static load depressions are reported) are reproduced in Figs. 4, 6 and 7.

With the jacking car (used for one and two-axle loads) it was possible to obtain the depression profiles under successively increased loads. Comparison of these curves revealed the fact that the track structure is elastic, virtually in the same way as a piece of steel, deformations being proportional to load. This is brought out by the curves of Fig. 9, derived from curves similar to those of Fig. 4. However, the statement strictly applies only to track in first-class condition. Track in poor or mediocre condition depresses more under the early stages of loading than subsequently, and its total depressions are considerably larger than those of good track.

Stone-ballasted track of good character was found to be only half as rigid as first-class track built for the heaviest and fastest traffic, but twice as rigid as light cinder-ballasted track. The rigidities are represented by what the committee calls "modulus of elasticity of rail-support," being the load per linear inch of one rail which will produce a depression of 1 in. The quantity was found to range from 500 lb. to over 2000 lb. in the different pieces of track tested.

Track in poor condition differs from track in good condition not only by having a lower modulus of elas-

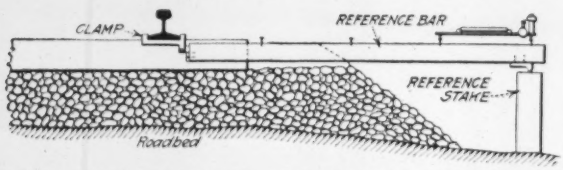


FIG. 1. MEASURING RAIL DEPRESSION BY LEVEL-BAR

ticity of rail-support, but also by having something analogous to vertical play. The left-hand depression curve (solid line) of Fig. 9 shows the relation of load to depression for a piece of track in need of tamping, while the curve to the right of it refers to the same track in well-tamped condition. The curvature or offset of the left-hand curve represents an apparent slack, which generally ran from 0.03 to 0.10 in. in track not freshly tamped, though it has been found to be as high as 0.20 in.

Most of the tests were made in duplicate, first with loads over ties and then with loads between ties. There was practically no difference between the two in depression or rail-stress.

The conclusion that the action of railway track is dominated by the general elastic reaction of the roadbed rather than by the individual tie reactions is further supported by the depression profiles under locomotives, in Figs. 6 and 7. These show a general depression over the entire loaded length, the wheel concentrations being distinctly evident and the supporting reaction being to all appearances uniformly distributed.

The influence of rail stiffness appears in the fact that the heavy rail sections, distributing the load over a greater length of track, produced somewhat lower track

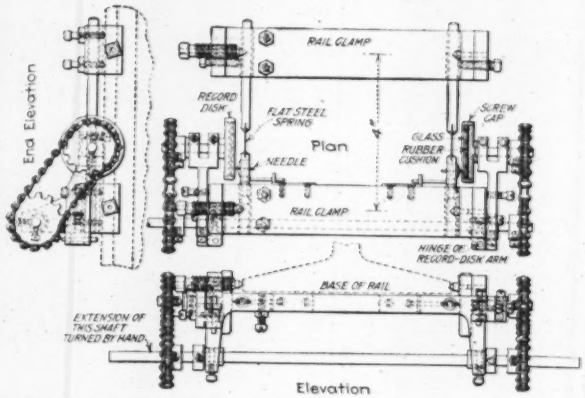


FIG. 2. FINAL FORM OF STREMMATOGRAPH FOR RAIL-STRESS MEASUREMENTS UNDER MOVING TRAINS

depressions than did lighter rail. The heavy rail was subjected to a greater bending moment, but at lower fiber stress, than light rail.

The physical condition of uniform cushioning, demonstrated by such curves as those of Fig. 9, furnished the committee a basis for deducing a theoretical formula for track depression and rail stress. Denoting by u the modulus of elasticity of rail-support, by y the track depression below its unloaded level, at any point along the track distant x from the load, the roadbed reaction is expressed by uy. This is the rate of increase of the track shear, and as the latter is the rate of change of the rail bending moment, the fundamental differential equation becomes $EI\frac{d^4y}{dx^4} = -uy$. Integrating this equation gives the depression formula

$$y = -\tfrac{1}{2}\frac{Pk}{u}e^{-kx}(\cos kx + \sin kx)$$

in which $k = \sqrt[4]{\frac{u}{4EI}}$ From this curve may be derived the expression for rail stress.

$$f = \frac{P}{4kI/c}e^{-kx}(\cos kx - \sin kx)$$

and the special values for the depression directly under the load, $-P/\sqrt[4]{64EIu^3}$ and for the maximum reaction, which occurs under the load, $\frac{1}{2}Pk$, or $Pu/\sqrt[4]{64EIu^3}$ per inch of rail. [This maximum reaction is the same as that which would be developed if the load were uniformly distributed along a length of roadbed equal to $\frac{2}{k}$, or $2\sqrt[4]{\frac{4EI}{u}}$. The latter expression gives, for ordinary roadbed (with $u = 1000$) and for rails from 85 to 125 lb. ($I = 27$ to 68.7), an effective distribution length of 85 to 107 in., and for more rigid roadbed (with $u = 1500$) 77 to 97 in. —Editor].

Fig. 11 reproduces the curves of depression and rail stress computed from the formulas. Where two or more loads are applied to the rail their curves will superimpose and the composite must be found by addition.

Fig. 12 shows the process and the result (heavy line) for a Mikado locomotive and for a four-axle car. The curves for the locomotive may be compared with those of Fig. 6. It will be seen that there is close agreement. Another comparison is given by the curves in Fig. 5, in which one line represents the observed rail stress under a two-axle load, another line represents the composite figure obtained by combining two observed curves of one-axle load, and finally, the third line is computed from the theoretical formula.

The values of the modulus of elasticity u are summarized by the committee as follows:

"The value for the modulus on the track of the Illinois Central R.R. with 24-in. ballast may be taken as about 1600 lb. per in. For the track on 6-in. and 12-in. ballast the values are approximately 1000, except for the track on 7 x 9-in. ties, where the values are higher, say about 1200. For the track used for freight service, which was ballasted with 6 in. of cinders in not very compact condition, the value is about 750. For the track of the Champaign & Havana branch of the Illinois Central R.R., with about 6 in. of fine cinder ballast above a light embankment of loam, tie spacing varying from 22 to 26 in., 56-lb. rail, the modulus of elasticity of rail support found was about 530. The track was not in good condition at the point where the test was made; some of the ties were partly decayed. The track of the Delaware, Lackawanna & Western R.R. was evidently stiffer than that of the Illinois Central R.R. The value 2200 lb. per in. per in. is probably representative of this track. The track had 18 in. of trap-rock ballast below the ties, and the material of the roadway below was such that it was very solid."

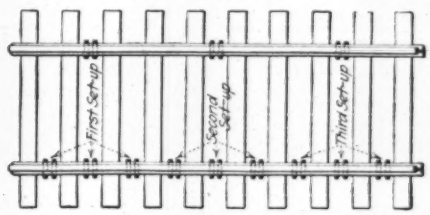


FIG. 3. STREMMATOGRAPH SET-UP

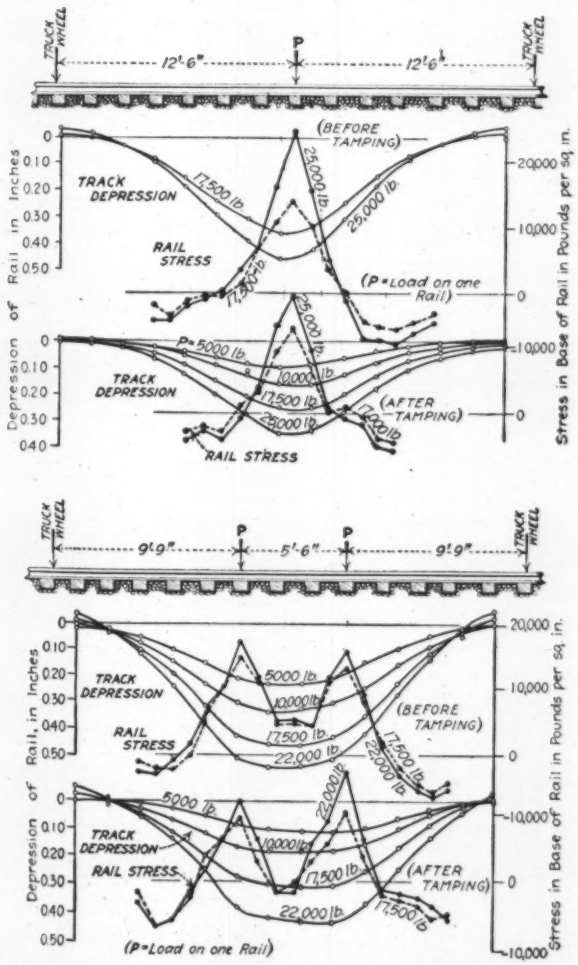


FIG. 4. DEPRESSION AND RAIL-STRESS CURVES FOR ONE AND TWO-AXLE LOADS

These curves agree closely with those computed from theory. Tests made on track with 85-lb. rail and 12 in. of stone ballast.

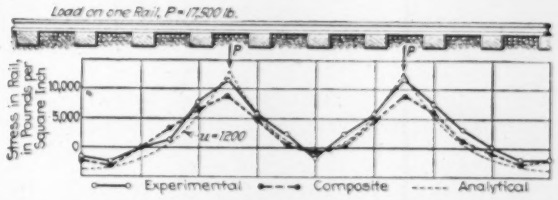


FIG. 5. THEORETICAL- AND OBSERVED-STRESS CURVES

Full line is observed-stress curve for track conditions as in Fig. 4, each load being 17,500 lb. per rail. Dotted curve was computed from formula. Dash curve is composite of two measured one-axle load curves.

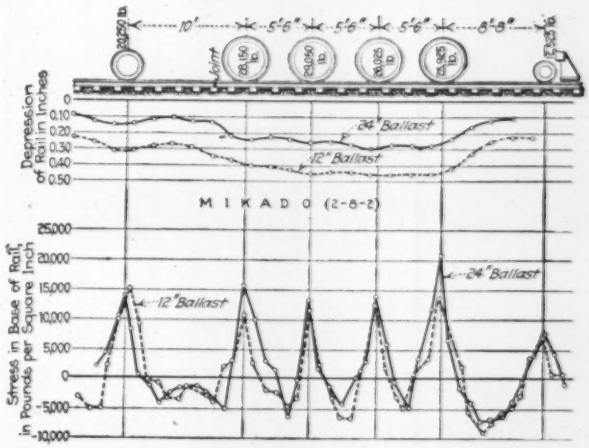


FIG. 6. DEPRESSIONS AND STRESSES UNDER MIKADO ENGINE FOR TWO DEPTHS OF BALLAST

Stresses measured in outer edge of rail base only; 85-lb. rail.

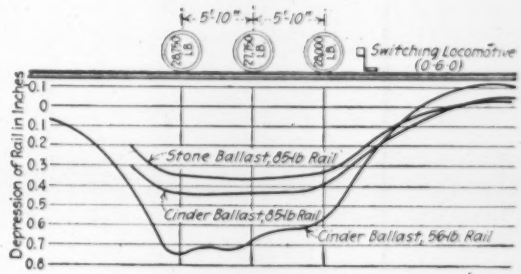


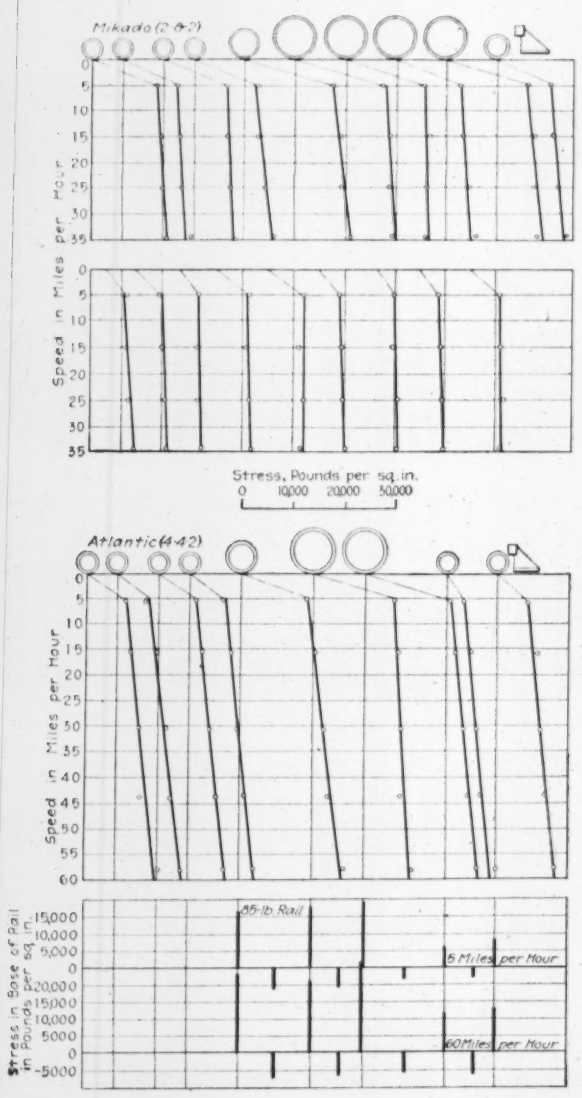
FIG. 7. DEPRESSIONS OF THREE ROADBEDS COMPARED

The important facts shown by the rail-stress measurements are contained in the typical curves of Figs. 4, 5, 6, 8, 9 and 10. The data given in the curves of Figs. 8 and 10 were made under moving locomotives, using stremmatographs arranged as in Fig. 3; it is to be remembered that 50 to 100 individual record disks are combined in each observation point recorded in the diagrams of Fig. 8. The curves under static load were obtained by measurements with the Berry gage. It is important to remember that the stresses measured are the longitudinal tensions and compressions in the rail base.

Separate sets of tests were made on the same track before tamping and after tamping. The rail stresses were lower after tamping. "For a rail of 85-lb. section the stress in rail in untamped track was found to be as much as 6000 lb. per sq.in. more than in freshly tamped track, and this was true whether the load was 10,000 or 50,000 lb. per axle or whether the stress for the freshly tamped track was 5000 or 20,000 lb. per sq.in. Tests have not yet been made to determine what the effect would be on track in poor condition."

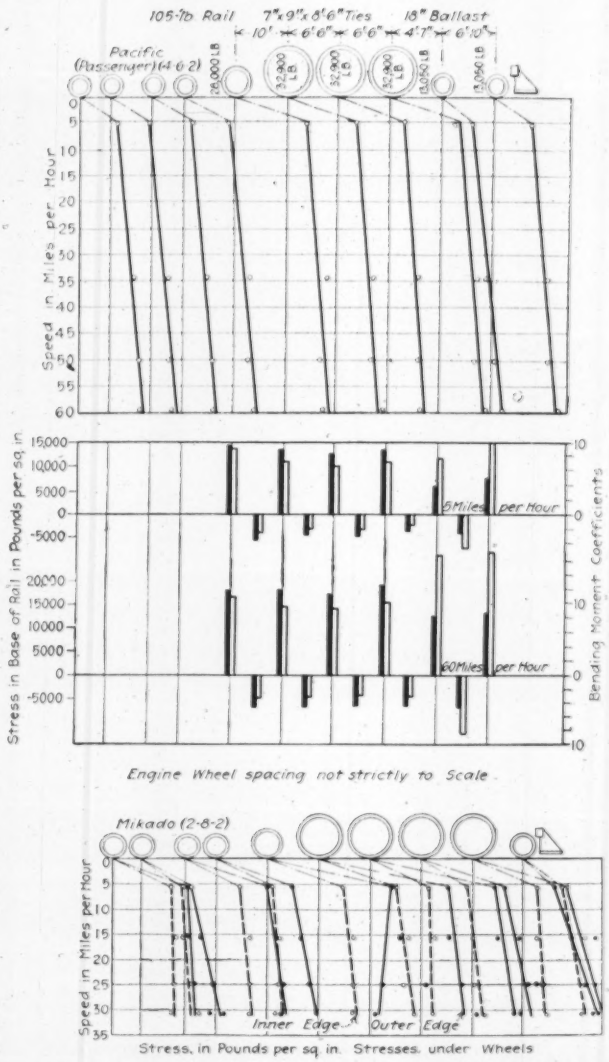
Rail stress also was found to be lower in heavy rail than in light rail. This point is brought out by the curves of Fig. 10. Depth of ballast did not affect rail stresses as much as deflections, but "the track on 24-in. ballast has somewhat smaller stress in the rail than that on lighter ballast."

While positive bending, with tension in the base of the rail, occurs directly under the load, negative bending (in which the rail head is in tension) is also an important phenomenon in rail action. Under the two axle


Mikado (2-8-2)
Speed in Miles per Hour
Stress, Pounds per sq. in.
0 10,000 20,000 50,000
Atlantic (4-4-2)
Speed in Miles per Hour
85-lb Rail
Stress in Base of Rail in Pounds per sq. in.
5 Miles per Hour
60 Miles per Hour

Upper diagrams are for Mikado locomotive with driver loads of 26,000 to 29,000 lb. Stresses under wheels and between wheels shown separately, the latter being negative; that is, compression in base of rail.

Lower diagrams are for Atlantic locomotive with driver loads of 25,000 lb. Below the speed-stress diagram is a plot of the stresses at two speeds. The diagrams in this column were made from measurements on well-tamped track having 85-lb. rail on 6 x 8-in. by 8-ft. ties on 12 in. of stone ballast.


105-lb Rail
7"x9"x8'6" Ties
18" Ballast
10' 6'6" 6'6" 4'7" 6'10"
Pacific (Passenger) (4-6-2)
32,900 LB
Speed in Miles per Hour
Stress in Base of Rail in Pounds per sq. in
5 Miles per Hour
60 Miles per Hour
Bending Moment Coefficients
Engine Wheel spacing not strictly to Scale
Mikado (2-8-2)
Inner Edge
Outer Edge
Stress, in Pounds per sq. in. Stresses under Wheels

Upper diagrams show speed-stress lines for Pacific passenger locomotive with driver loads of 32,900 lb., and plots of stresses (black) and bending-moment coefficients (light). These coefficients, multiplied by wheel-loads, give bending moment in rail in inch-pounds. Measurements were made on track in regular high-speed service, having 105-lb. rail on 7 x 9-in. by 8½-ft. ties on 18 in. of stone ballast.

Lower diagram shows lateral bending of rail indicated by difference of speed-stress lines for inner and outer flange of rail base. Measurements were made under Mikado locomotive on track having 6 in. of cinder ballast.

FIG. 8. SPEED TESTS—STRESSES IN RAIL MEASURED UNDER LOCOMOTIVES MOVING AT VARIOUS SPEEDS

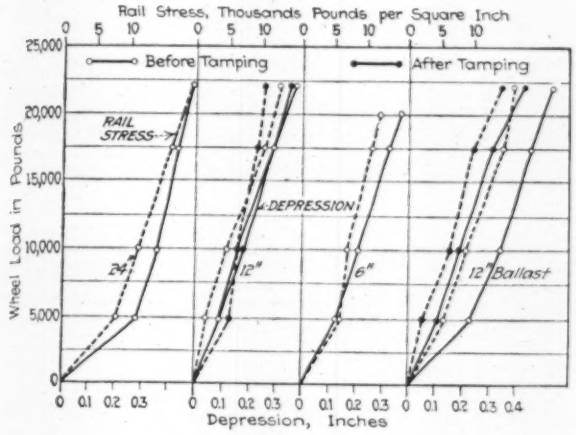


FIG. 9. DEPRESSION AND RAIL STRESS WERE FOUND TO BE PROPORTIONAL TO LOAD

loads represented in Fig. 5 the rail stress just falls to zero midway between wheels, but under locomotives reversed bending usually occurred between wheels (see Fig. 6). The largest negative bending was found between truck wheel and front driver of the locomotive. Both negative and positive moments are reduced by closer wheel spacing, it appears.

Under a moving locomotive the bending is distributed in the same way; two subsidiary diagrams in Fig. 8 bring out the negative bending between wheels.

In all the moving-load tests the driver counterweights were in lowest position when the front driver passed over the middle stremmatograph of the three. The drivers back of the first passed over the instruments when the counterweight was in other positions, and comparison of their records may be vitiated by this difference.

The study of the effect of speed on rail stress is the most important part of the moving-load tests. The committee concluded that a straight-line relation between stress and speed fits the results satisfactorily. The moment under the wheels increases about 0.3 to 1.2% for each mile per hour increase in speed above 5 miles per hour. "The heavier rail section appears to give a somewhat higher proportional increase of stress with increase of speed than the lighter. The indications in the tests on track of the Illinois Central R.R. are that the Mikado locomotive gives a rate of increase somewhat greater than the Atlantic and the Pacific. The tender trucks give a still higher rate of increase, though of course the amount of the stress is less than that under the drivers."

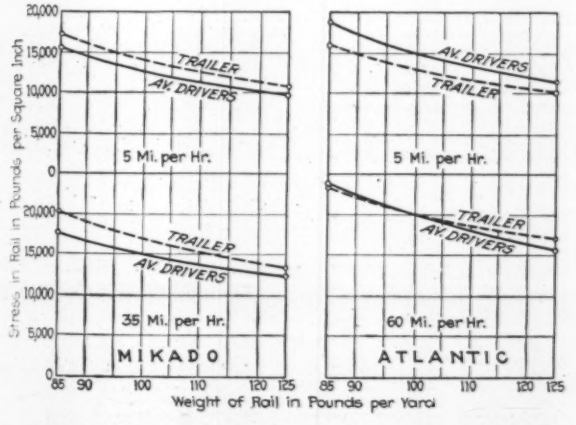


FIG. 10. HEAVY RAIL SHOWED LOWEST STRESSES

The statements concerning the effect of speed on rail stress apply only to speeds of 5 miles an hour and higher. The relation between stresses occurring under the standing locomotive and those developed at 5 miles per hour is not discussed in the report.

Special sets of moving-load tests were carried out to determine the effect of other factors on rail stresses. The following conclusions are important:

The prepared sections of track are representative of similar track under ordinarily good condition. In ordinary track, greater variation in results and somewhat larger individual values occur.

At a decayed tie, stresses from 20 to 40% higher than normal were measured. There was also more variation between inner and outer edges of rail base. Stresses at the outer edge of the base were found which averaged about 150% higher than the average rail stress for good track.

A low spot in the track, sufficient to give the locomotive quite a roll, produced rail stresses 15% higher

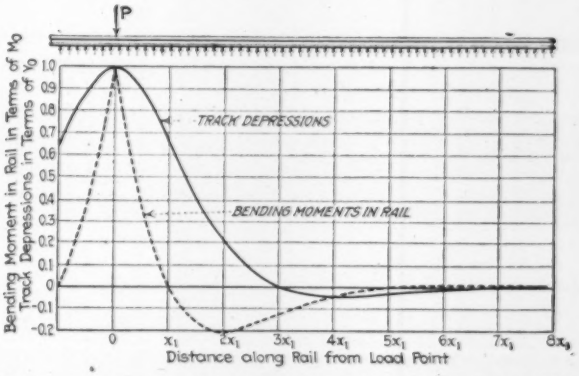

P
TRACK DEPRESSIONS
BENDING MOMENTS IN RAIL
Bending Moment in Rail in Terms of M0
Track Depressions in Terms of y0
Distance along Rail from Load Point

FIG. 11. DEPRESSION AND RAIL-STRESS CURVES COMPUTED FROM THEORETICAL FORMULA

than normal at low speed and 20 to 35% higher than normal at high speed.

Light track with 6 in. of cinder of ballast on loam subgrade showed stresses 12 to 18% higher than 6-in. ballasted main-line track, and also a greater variation of individual values.

Locomotive conditions may affect rail stresses seriously. One locomotive used for the tests was by accident found to have one of the driving wheel equalizers blocked up to relieve the load on one wheel. Rail stresses 70% above normal were found under the driver just back of this one, while the affected driver produced hardly 20% of the normal stress.

Under the loading car and jacks used for applying the single and two-axle loads the stresses in the two flanges of the rail base were substantially equal. On the other hand, under locomotives, whether standing or moving, the flanges showed large stress differences, as already mentioned. Usually the stress in the outer flange was the higher (Fig. 8). Close observation showed that immediately under the wheel the rail was

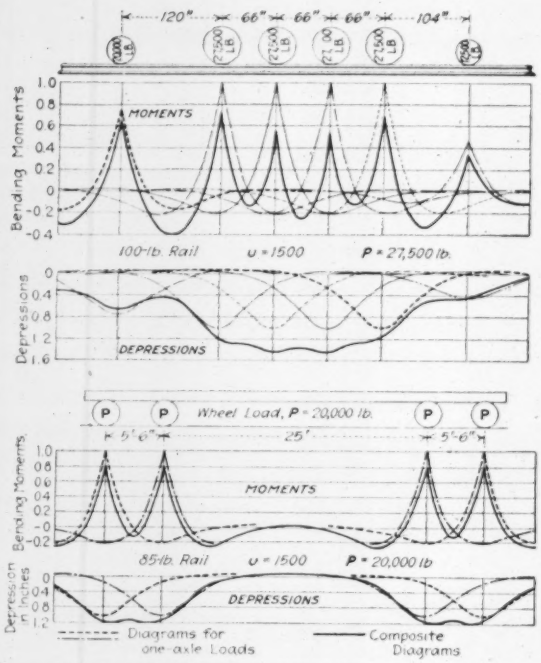


FIG. 12. COMPOSITE THEORETICAL CURVES
The locomotive curves are similar to those plotted from measurements in the track.

outward of its normal position and between wheels was inward of its normal position, the displacement ranging from 0.01 to 0.03 in. (in 85-lb. rail). Thus the rail under a locomotive is bent into sinuous form and the stress differences between the flanges correspond to this fact. The ratio of the stress in the outer flange to the stress in the inner flange varied over quite a range, and frequently was above 3. "To what extent the coning of the wheels contributes to the outward bending of the rails and what other factors enter into the action will not be discussed in this report."

Lateral strength of the rail is therefore an important element of track strength. The bending moment in lateral direction is much less than the vertical, but its effect in increasing the fiber stresses must be taken into account.

In tests under moving locomotives on track in first-class condition, the stress difference between the outer and inner flange usually remained constant throughout the speed range. On light track in ordinary condition the differences were erratic; at one wheel the difference would increase with increase of speed, and at another wheel it might decrease (lower right-hand diagram in Fig. 8, taken on cinder ballast).

Many other subjects have been studied after those reported upon. The recent work included measurements of the depression at various points below the tie and in the ballast, pressure in the ballast, bending of the tie, effect of counterweight and excess counterweight on the rail, and study of the effect of curves.

The committee is made up of the following members: Prof. Arthur N. Talbot, chairman; A. S. Baldwin, G. H. Bremner, John Brunner, W. J. Burton, C. S. Churchill, W. C. Cushing, R. W. Hunt, G. W. Kittredge, P. M. LaBach, C. G. E. Larsson, G. J. Ray, A. F. Reichmann, H. R. Safford, F. E. Turneaure and J. E. Willoughby.

Improved Waste Collection and Disposal Recommended

Three-Separation Plan for Baltimore—Garbage Reduction, Rubbish Utilization and Incineration, Ashes for Filling

BY WALTER E. LEE
Water Engineer of the City of Baltimore.

GARBAGE disposal by reduction, waste disposal by sorting and sale, with incineration of tailings, and ash disposal by filling marsh lands, together with various improvements in the collection of all wastes, were recommended by the writer in a recent report made to James H. Preston, mayor of Baltimore, Md. To carry out the garbage-disposal recommendation, the writer has already drawn specifications for a 300-ton "closed" system of garbage reduction, to be operated under a contract running 11 years from Jan. 1, 1919, the bids to be made alternatively on a yearly lump sum and a price-per-ton basis for garbage and dead animals delivered to the contractor by the city.

The plant would be located within the city, on at least five acres of ground, on either a railway line or a navigable waterway.

Baltimore is located on a tributory of Chesapeake Bay. It has an area of 30.1 sq.mi. and an estimated population (Jan. 1, 1918) of 593,000. For waste collection purposes it is divided into four main districts and 192 collection routes. Householders place garbage in one receptacle and ashes and rubbish together in another. Since Oct. 20, 1902, the garbage has been disposed of by the Arnold-Edgerton reduction process. In 1908 the reduction plant was removed from its original location to a barging distance of 16 miles from the city. Grease is recovered by steam cooking and tankage pressing, without percolation. The contract expires Dec. 31, 1918.

The average garbage production of the city from households, markets and packing houses is 0.58 lb. per capita daily, with 0.68 lb., or 15% above the average in late summer. The yearly collections for the past ten years and the monthly fluctuations in 1917 are given in the accompanying tables. At present some garbage is given to farmers by its producers and some is burned on the premises, but most of it is collected by the city and turned over to the owner of the reduction works.

YEARLY COLLECTIONS OF GARBAGE AND DEAD ANIMALS AT BALTIMORE, MD., 1908 TO 1917

Year	Garbage from All Sources—Tons	Number of Dead Animals	Estimated Population
1908	54,000	13,754	569,000
1909	46,900	14,637	576,000
1910	44,500	17,790	559,000
1911	48,300	19,792	565,000
1912	49,200	20,498	568,000
1913	53,400	16,561	573,000
1914	59,100	15,993	578,000
1915	61,500	14,459	583,000
1916	62,400	17,419	588,000
1917	62,300	20,178	593,000

MONTHLY FLUCTUATION IN GARBAGE PRODUCTION, BALTIMORE, MD., FOR THE YEAR 1917

Month	Tons	Month	Tons
January	4,566	July	7,577
February	3,089	August	7,399
March	3,594	September	6,886
April	3,334	October	7,096
May	4,979	November	4,517
June	5,475	December	3,749
		Total	62,261

Ashes and household rubbish are now disposed of by dumping on land or into water.

In the report already mentioned, the writer recommended the three-separation plan, the garbage and ashes to be placed separately in standard galvanized-iron receptacles, uniform in size and shape, and that the rubbish be tied in bundles; that incineration of garbage at the point of production be prohibited; that the city collect all garbage from every place where food is prepared for human consumption; that the city discontinue the collection of all trade wastes resulting from the preparation of food for profit, but accept it at the dumps when delivered by private collection carts which have been licensed by the commissioner of street cleaning.

Three-Compartment Collection Trucks

Under collection, the report recommended that garbage, ashes and rubbish all be collected in the same trucks and trailers during a single collection trip, but be kept separate in compartments provided for that purpose.

These carts should be of steel, with semi-cylindrical covers and sliding dumping levers, and should displace all the present wooden carts as rapidly as the latter wear out.

Reducing Garbage-Collection Haulage

To reduce the increasingly long haul of garbage in the northern and western districts it is proposed that the garbage be dumped from the collection carts at a station in each district, over a platform or through chutes into two or three five-ton trailers of a tractor-drawn garbage train running to the waterfront garbage loading stations. In like manner ash-haulage costs should be reduced, where long hauls are required, by transferring the ashes from the collection carts to 8-cu.yd. removable steel bins, placed on trolley flat cars.

The main features of the recommendation for garbage disposal have already been given. The city would deliver the garbage to the contractor's scows on the waterfront, or else directly to the reduction plant, depending on its location. The city would have the option of buying the works at the end of the contract on a proper basis of first cost, depreciation and earnings. The reduction process must be conducted without vapors, smoke or odors.

Ashes and Rubbish Disposal

Ashes would be used to fill low places or dumped in ravines already sewered, on marsh land, or behind bulkheads at the waterfront. Locomotive cranes and belt conveyors should be used more extensively than at present to unload and distribute ashes at the dumps, especially at the water-edge sites. Existing waterfront garbage-loading and ash-loading stations should be rebuilt and housed so as to prevent the escape of ash dust and of odor in hot weather.

Combustible but unsalable rubbish should be burned in small incinerators at each district loading station and the combustible and unsalable refuse disposed of with the ashes. The sorting privileges for salable rubbish, including rags, rubber, bottles and metals, should be sold annually to the highest bidder.

Finally, the report recommended that street sweepings be collected separately from ashes, delivered to the nearest district loading station, and sold under a contract awarded annually to the highest bidder, the contractor to have the right to take only those loads having reasonable fertilizer value. To clean downtown business streets paved with sheet asphalt a gasoline-driven vacuum cleaner with storage trailer should be bought for use for night cleaning during dry weather.

Safety Engineering a Benefit to One Contracting Firm

How Accidents Decreased Under a Campaign and How Most Common Ones Were Analyzed and Reduced

ORGANIZED effort to prevent accidents is now common in industrial works, but in the hazardous building trades, in all forms of construction work, in fact, the "safety-first" movement is not so definitely established, although the compensation laws now in effect in most states lay a heavy tax on all construction operations. How one contracting firm, Fred T. Ley & Co., Inc., of Springfield, Mass., has practiced safety engineering with growing success was told by L. D. von Woedtke, director of safety for the company, in a paper read before the annual meeting of the Connecticut Society of Civil Engineers at Hartford, Conn., on Feb. 20. Mr. von Woedtke's paper is given in abstract herewith.

General contracting in its many branches is considered as a high hazard. This fact is attested by the high liability rates charged by insurance companies and authoritative statistics compiled in every state in the Union, as well as by the United States Government. In spite of this fact there seems to be less organized or systematic safety work being done by contractors as a class than almost any other branch of industry. This statement is attested by the fact that the National Safety Council, with its great membership of more than 3500 firms and corporations employing more than six million workmen in almost every known line of industry, has but fifteen building contractors in its entire membership. Safety work in general contracting does pay from every possible standpoint, and instead of being a costly hobby which slows down production it actually increases and speeds up production, both in quantity and quality. The time and money spent in safety work not only comes back but eventually results in a new form of dividend, heretofore not considered, under profit and loss.

A chart of Fred T. Ley & Co., Inc.'s, lost-time accident classification given herewith shows comparisons for the last three years. Using 1915, when they started systematic and organized safety work, as a basis, the reduction in accident rate per 1000 employees for 1916 was 25%, and for 1917 was 55%. The highest quarterly reduction was 80% for July, August and September, 1917. By way of comparison the accident cost reduction for 1916 was 53% and for 1917 was 66%. A chart reproduced shows under different classifications the number of accidents per 1000 employees and the percentage of reduction in each year for different causes.

For the future there will be added four additional main causes, and when the monthly compilation of this data shows any cause or causes running high in percentage they will be subdivided for two or three months to locate the particular occupation requiring special attention.

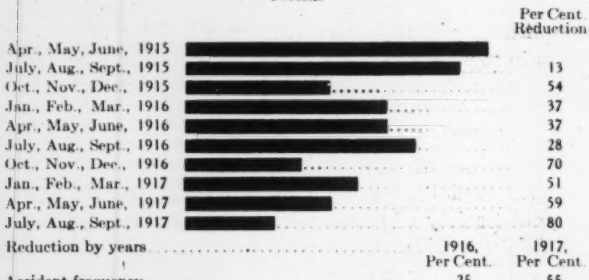
The figures given do not include the work at Camp Devens, Mass., as that contract was so large and out of the ordinary that its experience would give the chart and classifications a false or padded result.

The success in accident prevention attained by this contractor is due to a constant and systematic program of education and to the installation of mechanical safeguards. It was helped through the enlistment and maintenance of the coöperation of the superintendents, foremen, timekeepers and men in the field. It is estimated that not more than 30% of all accidents can be

LOST TIME ACCIDENTS

Apr. 1, 1915 to Sept. 30, 1917 Inclusive

Per Cent Reduction in Accident Rate Per 1000 Employees, Shown By Quarterly Periods


Per Cent Reduction
Apr., May, June, 1915
July, Aug., Sept., 1915 13
Oct., Nov., Dec., 1915 54
Jan., Feb., Mar., 1916 37
Apr., May, June, 1916 37
July, Aug., Sept., 1916 28
Oct., Nov., Dec., 1916 70
Jan., Feb., Mar., 1917 51
Apr., May, June, 1917 59
July, Aug., Sept., 1917 80

Reduction by years	1916, Per Cent.	1917, Per Cent.
Accident frequency	25	55
Accident cost	53	66

eliminated by mechanical safeguards and that at least 70% must be eliminated through safety education.

The company's educational program consists mainly of periodical letters, of encouragement, advice, suggestion and constructive criticism, quoting always some specific types of accidents which are showing a high percentage and always stating or suggesting specific remedies. In this way, by making a drive against one or two specific causes at a time, accidents from all causes have been reduced. Suggestions and ideas are also encouraged and wren received they are quoted in the general safety letters. Many of the best methods have been secured in this way. Snappy safety slogans are also used at the foot of all letters sent out by the safety and protection departments. These continually keep the men thinking safety.

Bulletin boards are, of course, posted on all jobs, and fresh bulletins are supplied periodically. Four bulletins are sent at a time, most of which are posted temporarily until new ones are received. Some are posted permanently. The job bulletin board is usually three or four feet square, and shows about twelve bulletins at a time. The larger jobs have more than one bulletin board, so that they may be readily seen by everyone. Men will look at striking illustrations, and read large type, who might otherwise never get the "safety bug." The foreign laborer will also look at pictures even though he cannot read the type. Most of these bulletins are from the National Safety Council and insurance companies, but many are made up by the company.

To give some idea of the possibilities for safety work in general contracting there are stated below a few methods which have been employed by the Ley company to reduce each of the eight main causes of accidents quoted in the beginning of this paper.

Handling Materials—(1) Proper piling and bracing of supplies of lumber, pipe, brick, cement, etc. (2) Stout, sound runways and platforms of selected materials and proper construction. No makeshifts by workmen allowed. (3) Wheelbarrows, scale boxes, blocks and falls, dump and flat cars, etc., kept in good condition, or discarded if unsafe. Constant inspection made and employees requested to report all unsafe conditions. (4) Continual cautioning by foremen against the "dropping" habit.

Falling Materials—(1) Skirt or toe boards on stagings, scaffolds and on all exposed edges of floors and elevator shafts, openings, etc. (2) Use of closed-in chutes for rubbish and waste disposal. (3) Daily inspection of all hoisting apparatus and equqipment on the job, and thorough overhauling at main equipment plant when returned from or sent to a job. (4) Tables of safe loads for ropes, chains and cables, also slings, at various angles.

Employees Falling—(1) Railings on pits, staging, scaffolds, and unused sides of floor openings for ladders, etc., and elevator and hoist shafts. (2) Passageways, floor and working spaces kept clear of waste and surplus materials. (3) Good ladders with safety feet where advisable, or toed, braced or lashed, to prevent slipping. (4) Gates and railings at elevator and hoist shafts, located far enough from openings to prevent anyone leaning over being struck by car or bucket.

Handling Tools—(1) On all jobs tool houses, and tool men provided to inspect, repair or sharpen all tools. (2) Plenty of tools provided, allowing one or more sets being repaired or sharpened while others are in use. (3) Heads of all bullpoints, chisels, drills and hammering tools dressed and trimmed every time points or edges are sharpened, thus eliminating burred or mushroomed tools. (4) All handles tightened or new handles put on when they appear unsafe.

Nails—(1) Water boys, tool men, etc., equipped with hammers, and they constantly bend over or pull out protruding nails. (2) Stripped forms piled clear of passageways as taken down and protruding nails piled downward. (3) All loose boards or planks with protruding nails continually picked up, or nails bent over by all men on the job.

Flying Materials—(1) Goggles on every job, in every tool box and tool house. (2) Foremen held responsible for men wearing goggles, when chipping, drilling concrete, stone, steel, etc. (3) Extra sets of chipping or drilling tools provided to allow one or two sets always being repaired or sharpened while others are in use.

Machines—(1) All gearing, revolving projections, keys, setscrews, clutch-jaws, etc., thoroughly inclosed on mixers, hoisting engines, drums, winches, cranes, steam shovels, saws, etc. (2) Headless setscrews, shaft and pulley housing wherever practicable. (3) Adequate grab handles and steps on locomotives, cranes, steam shovels, cabs, dump and flat cars, etc. (4) Correct guards on gage glasses and water columns. (5) All saws, circular, split, crosscut, overhead or treadle swing, band, etc., equipped with approved safeguards, such as

spreaders, blade inclosures, travel limits, table guards, etc. (6) Jointers or buzz planers provided with cylindrical or safety heads. (7) Pulley blocks equipped with side plates or flanges, to protect mesh joint between ropes and blocks. (8) Hooks for large hoists, cranes and derricks, provided with handle on back.

Miscellaneous—(1) Acid carboys equipped with wooden frame inclinators. (2) Electric wires, switches, transformers, etc., protected against personal contact wherever possible by barriers, inclosures. (3) Adequate shoring in excavating, or tops kept broken down to prevent caveins. (4) Appropriate danger signs, tags and warnings. (5) Boilers safely housed, smokestacks fitted with spark guards, salamanders fitted with spark screens. Fire extinguishers provided on all jobs.

PER CENT. REDUCTION IN THE NUMBER OF LOST TIME ACCIDENTS PER THOUSAND EMPLOYEES SHOWN BY YEARS

Classification of Accidents	1st Year, 1915 No. Accidents Per 1000 Employees	2nd Year, 1916 No. Accidents Per 1000 Employees	Per Cent. Reduction	3rd Year, 1917 No. Accidents Per 1000 Employees	Per Cent. Reduction
Handling material	72	55	24	33	54
Falling material	63	35	44	16	75
Employees falling	61	43	30	28	54
Handling tools	32	28	12	13	59
Nails	80	71	11	42	47
Flying material	12	21	*75	9	25
Machines	24	9	62	6	75
Miscellaneous	55	41	25	33	40
Total average reduction			25		55

* Increase.

Outfall Sewer of Poor Concrete Pipe Disintegrates

Cement in Section Exposed to Septic Tank Gases Crumbles After Pipe Had Been in Service Only Two Years

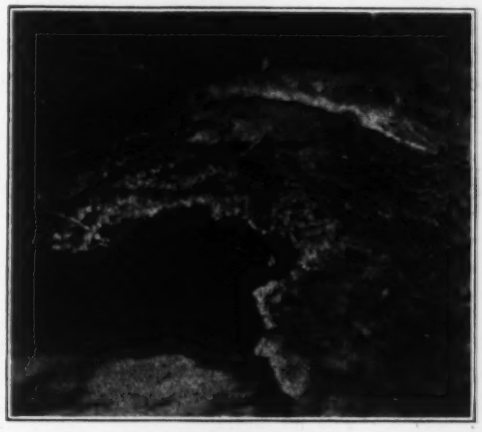
By H. L. Sherman
Civil Engineer, Calexico, Calif.

THE disintegration and failure of a small low-grade concrete sewer pipe carrying sewage effluent from a septic tank occurred during the past two years under the observation of the writer. Apparently the gases carried forward by the tank effluent caused the mischief.

In September, 1915, the outfall sewer at Calexico, Calif., was extended 450 ft. over a silt deposit formed in the channel of New River. As it was to be subject to occasional submersion it was necessary to anchor the pipe. This was done by laying the pipe on two 4 x 4-in. stringers supported on hand-driven pile bents, 12 ft. c. to c. The pipe used was a standard type of taper-and-bell, hand-tamped, concrete pipe, and was not of very good grade, either in point of tamping or richness of mixture. It was just such pipe as would be found in the ordinary small pipe yard.

The end of the line discharged into the stream of waste water continually running in the New River channel bottom and at times the sewage was checked up in the pipe by high water. This checking of the flow in the pipe line was rare, however, and at other times the pipe ran half full or less. The estimated flow was from $\frac{1}{3}$ to $\frac{1}{2}$ sec.-ft. The sewage is entirely domestic in origin, contains no industrial or manufacturing wastes, and is treated for a period of about six hours in combination sedimentation and septic tanks. The effluent of the tanks is clear, although it carries some material in suspension, is light yellow in color, and is strongly impregnated with hydrogen sulphide gas.

It took almost exactly two years for the pipe to fail. The disintegrating action of the sewage reached its maximum at the top of the crown, and was almost negligible on that portion of the pipe always shielded by the sewage from any gases not in solution. The writer



A WHITE POWDERY DEPOSIT APPEARED ON THE CRUMBLING CONCRETE SEWER PIPE

IN SOME SECTIONS THE COLLAPSE OF THE ARCH RESULTED

having no laboratory facilities at his disposal, can only describe the results as they appeared. The pipe decay did not apparently affect either the sand or gravel, but attacked the cement. As the sand and gravel became loosened it was washed away.

First came the preliminary signs of decay, a brown streak slightly less than $\frac{1}{16}$ in. deep. Next came a change in the concrete, which, although apparently the same in texture, changed in color from its natural gray to white. After this the disintegration varied in regard to the swelling of the white deposit which had either taken the place of the cement or else was the cement itself in modified form. As the gravel and sand disap-

peared a coating of this white deposit was left on the shell of the pipe, perhaps $\frac{1}{16}$ in. thick, and in small rounded lumps. This deposit, except for lack of crystalline structure, resembled a high-grade table salt, and packed about the same when damp. As the course of decay worked out through the pipe, the shell became weakened so that blows from without and pressure from within caused the failure of the upper half of the pipe. The illustrations show a near view of the failure of one joint of pipe and a general view of the line. The extra stiffening of mortar at the joints enabled these portions of the line to remain intact until the time of removal; eventually they would have gone also.

At some time in the life of the pipe line a settlement occurred near the lower end and a break here enabled the sewage to escape, so that the remaining portion of the pipe was saved from the final decay. By November, 1917, the top of about 250 ft. of the line had failed, allowing the sewage to flow over the silt flat, making a small swamp with heavy undergrowth. This caused such a nuisance that the entire line was removed and promptly replaced by a vitrified pipe of the same size on new stringers. Where the sewage flowed into the concrete line which failed it was carried by a vitrified line which shows no signs of decay, although the mortar joints are weakening slightly.

Ice Gorges on Mississippi River Sink Many Vessels

Loss of Packets, Barges and Towboats May Hamper Inland Navigation During 1918 Season Through Shortage of Craft

ABNORMAL ice conditions prevailed on the rivers of the Mississippi Valley during the past winter months. Many river vessels were lost, and it is likely that the development of river transportation this year to supplement railroad freight service will be hampered by the reduction in number of river craft and the impossibility of replacing them in time for service during the summer. The fixed works of the rivers fortunately suffered little damage.

Gen. W. H. Bixby, in charge of the U. S. Engineer office at St. Louis, furnishes an interesting record of ice and water conditions on the Ohio and Mississippi, and of the damage done. Summarizing, he says that the winter has been the most remarkable in the history of the Western rivers, the temperatures and gage readings have been the lowest, the ice has been the thickest and most widespread, the gorges most numerous and extensive, and the damage to vessels the most serious.

"On Dec. 1 the gage at St. Louis read 2.4 ft., and that at Cairo 9.2 ft. Moderate weather continued until Dec. 8, but with a temperature at Cairo on Dec. 9 of —8°, heavy newly made ice began running in both the Ohio and the Mississippi. On Dec. 7, 8 and 9 about 6 in. of snow and sleet fell. The boats and barges in the vicinity of Cairo were soon frozen in. By Dec. 16 the Mississippi was filled with ice from bank to bank; ice gorges were reported at Metropolis and Evansville on the Ohio, and at O'Briens (12 miles below Cairo); at Hickman (36 miles), and at Randolph Bluff (183 miles) on the Mississippi.

"Two weeks of more moderate yet freezing weather was followed by another cold snap on Dec. 29, and the water at Cairo, which had been rising from stage 4.0 on Dec. 16, when the gorge formed below, began to rise at the rate of nearly a foot a day (on Jan. 17 the rise in 24 hours was 7 ft.) until Jan. 21, when it reached 32.8 ft.

"On Jan. 4 a gorge in the Ohio above the Illinois Central bridge at Cairo let go and did considerable damage to the smaller craft in the Cairo harbor, and to many large towboats and barges on the Kentucky shore opposite. More moderate temperatures during the first ten days of January were followed by the coldest weather experienced in the Middle West for twenty years, with —19° at Cairo on Jan. 12. The Ohio and Mississippi were soon frozen solid from shore to shore, an unprecedented condition, as far down as Columbus, Ky. (23 miles below Cairo), which became the foot of the first ice gorge below Cairo. Enormous gorges existed farther down, at Barfield and Osceola (142 and 165 miles below Cairo), and at Richardsons and Seyppels (31 miles above and 30 miles below Memphis). At Vicksburg only a 200-ft. channel remained open, and floating ice extended as far south as Baton Rouge, nearly a thousand miles below Cairo. Ice in large quantities was also being discharged by the White and Arkansas rivers.

"The ice at Cairo started moving on Jan. 17, and a Government snagboat was badly damaged by the ice and wreckage sweeping by. The movement continued several days. The gorges just below Cairo shifted several times, drawing steadily higher and more solid. Two steamers value at $50,000 each were sunk just below Memphis, a Government towboat, a Government grader boat, and a large material barge were sunk at Barfield Landing, three valuable coal barges were torn away from the West Kentucky Coal Co.'s fleet at West Memphis and carried down the river, and a big wharfboat at Cairo was crushed by the ice and sunk. On Jan. 22 the three big gorges between Cairo and Memphis seemed more extensive than ever, the one at Columbus, for example, extending up the Mississippi and Ohio past Cairo, a total distance of 30 miles. On Jan. 26 the ice ran out of the Ohio for 4½ hours, leaving the river clear up to Paducah, but three days later the ice started running again, and a large steamer and four steel barges belonging to the Government were torn loose and carried downstream, two of the barges being sunk. The river rose from 34.4 ft. to 37.4 ft., but on Jan. 30 a gorge at Columbus broke and the stage at Cairo fell to 30.8 ft. in three hours.

"The greatest damage to shipping occurred on Jan. 29, in the mouth of the Tennessee River at Paducah, Ky. For more than thirty years the Tennessee had proved an unusually safe harbor. Yet four large packet boats value at $350,000, among the largest and best on the river, were lost here; to replace them at present prices would cost more than half a million dollars. Several smaller packets were sunk, and many vessels were swept away, including six towboats worth $200,000 and dry docks, barges and smaller craft worth as much more. At Caseyville, Ky., the moving ice cut down and totally wrecked two stone-filled wooden breakwater cribs and 19 loaded coal barges. Farther up six steel

barges, 40 wooden coal barges, and the entire construction plant of the contractor for the Government dam at Henderson, Ky., were carried away. The lighthouse tender and all available towboats of the Mississippi River from Vicksburg to Cairo are every day catching helpless floating plant and tying it up to the bank.

"As a result of the warm weather from Feb. 6 to 10 the gorges in the Mississippi between the mouth of the Missouri and the mouth of the Ohio, a distance of 200 miles, began breaking on Feb. 10 and three days later the ice was running freely throughout this district. As the gorged ice from above St. Louis swept through the harbor on Feb. 13, a wharfboat, three contractors' barges and one city barge were sunk. The following day the ice gorge in the Mississippi at Alton, just above the mouth of the Missouri, moved out and the ice began running out of the Missouri and Illinois rivers. The Illinois on Feb. 15 was open for its entire length, but ice gorges still held at various points on the upper Mississippi, at St. Charles, Hermann, and many other places on the Missouri, and at numerous points on the other tributaries of the upper Mississippi. Little or no damage to boats by the breaking up of the ice is expected on these streams, as they as a rule are safely harbored in bays or sloughs. It is not probable that much additional damage will be done to the boats in the St. Louis harbor as the ice comes down.

"So far as known there has been no unusual amount of damage done to the wing dams and revetment works on the Mississippi and its tributaries.

"The water at St. Louis has remained low throughout the winter, being below zero of the gage continuously (excepting one day) from Dec. 10 to Jan. 10. A minimum of —3.1 ft., on Jan. 20, was the lowest reading in the history of the gage.

"The effect that this unusual winter is likely to have on the navigation of Western rivers in the future cannot be determined as yet. The immediate effect during the coming season will be a considerable shortage of boats, as it will be almost impossible now to build new boats in time for use during the coming season. It is believed, however, that the disheartening effect on those who lost vessels will be temporary, and that the usual ice damage of the present winter will be recognized generally as in the nature of a catastrophe not likely to be repeated for a great many years."

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

The Labor Situation

Sir—The courage necessary to express editorially the thoughts on the labor situation that you have in the last two numbers is indeed very great. Your editorials will be misunderstood in many quarters, but I am certain that your views will take solid root, because the ground is thoroughly prepared for a healthy growth, and I am very glad that *Engineering News-Record*, for so many years the cleanest engineering publication, has taken the initiative so necessary in any big industrial change. P. J. SIMMEN.

Buffalo.

A Voice from the Other Side

Sir—Lately there have come to hand several proposals and counter proposals referring to alterations to the constitution of the American Society of Civil Engineers. The latest is worded so you cannot vote "No" without danger of its meaning "Yes." A Philadelphia lawyer would be strangled by the insincere wording of the latest revision.

I am anxious to see some life in the society. The fact that individual members are devoting their time to war work should not permit the society as a whole to dodge the present-day issues. I want to vote a censorship on the present management, which is the same clique which has conserved our energies for the past few years to a point of narrow-mindedness. I wish to point out at this time that there is nothing remarkable about the growth of the American Association of Engineers, which lately has had such an influx of the live engineers of America. It is only the reflex action caused by inactivity and conservatism on the part of the management of the parent societies. Let us open the gates of coöperation rather than raise the bars of class and caste.

I wish to take this opportunity to compliment *Engineering News-Record* on its up-to-date policy of articles and news of topics of interest of the day. I now look forward to the arrival of the *News-Record* with as much interest as I do the coming of the *Literary Digest*, and am sorry to say the *Proceedings* of the American Society often remain on my desk unopened for several weeks.

Kindly fill in the inclosed American Society ballot as I should wish it to be and forward to the secretary.

E. W. SAWYER,

London, England. Contracting Engineer.

[Mr. Sawyer's letter was written Feb. 20. It arrived Mar. 7, the day after the vote on the revised constitution was canvassed. As Mr. Sawyer thus lost his vote by a day it seemed only fair to give him this opportunity of expressing his views—even though the issue is settled for the present.—Editor.]

Cold Asphaltic Oil for Preliminary Road Treatment

Sir—I have noted with interest the article in *Engineering News-Record* of Jan. 10, p. 76, concerning bituminous surface treatment for highways. One of the points which should be more forcibly pointed out to engineers in charge of road maintenance is the fact that a macadam road which has first been treated with a priming coat of cold asphaltic road oil and sand, before receiving a surface of heavy oil applied hot with stone chips, produces a most satisfactory surface. For six years the writer has been applying road oils of an asphalt base on about 200 miles of macadam roads. On some of these roads the cold oil and sand

treatment was adequate for a year. The next year a treatment of heavy oil and chips was applied and when this was done there were fewer pockets and a more durable surface the following year.

In this vicinity I recommend that macadam roads be treated first with road oil—the following year with heavy oil and chips. This is a real economy, because sand of a satisfactory quality is found in abundant quantities and the cost of application is less.

Bituminous surface treatments are not satisfactory for heavy automobile trucking, but have proved adequate for pleasure-car traffic and agricultural hauling. A system of macadam roads which does not furnish a smooth surface for automobile traffic can readily be placed in condition at the least expenditure by surface treatments than can any other type of road. I do not mean to discount bituminous concrete surfaces placed upon old macadam bases, for they are much superior.

JAMES LOGAN,
County Engineer, Burlington County, New Jersey.
Mount Holly, N. J.

Relining Railroad Curves

Sir—In an interesting article in your issue of Jan. 24, p. 173, by C. E. Newell, entitled "Externals Instead of Tangent Distances for Lining Railroad Curves," one erroneous assumption is made. It is assumed that the line bisecting the angle DCE also bisects the angle DFE, which is not, in general, true. The correct method would be to make the azimuth of FM the mean of the known azimuths CD and CE.

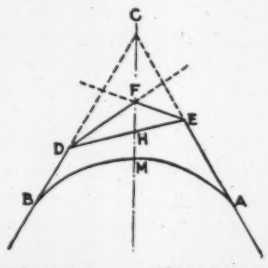
Ephrata, Wash. NORVAL ENGER.

Sir—The article on p. 173 of your issue of Jan. 24 on the use of externals instead of tangent distances for lining curves was interesting. It would not, however, admit of wide application, as it certainly would be of no use with a compound curve.

If the described method is used to determine the degree of a curve, it will be approximate if the curve is out of line, and it would seem advisable to check capitulation by arriving at the tangent distances for the trial degree found. In any event, it does not seem that there is any great saving of labor, even for small curves.

T. H. GORDON,
Assistant Division Engineer, Baltimore & Ohio R.R.
Philadelphia.

Sir—In *Engineering News-Record* of Jan. 24, p. 173, there is an article by C. E. Newell on "Externals Instead of Tangent Distances for Lining Railroad Curves." In this article the author has outlined a simple solution to the problem in question. The writer, however, wishes to take exception to one step in the solution.



After having located the point F by bisecting the angles CED and CDE, the author says: "Obtain an intersection of the line bisecting the angle DFE with the line DE at H, and the plus to the intersection of the line FH produced with the center line of the existing curve at M." The writer wishes to call attention to the fact that the line CM does not bisect the angle DFE unless DC equals CE, and hence the line bisecting the angle DFE does not necessarily coincide with the external. The line CM can, however, be located quite readily; thus,

$$\angle EFH = \angle FCE + \angle FEC$$
$$\angle DFH = \angle FCD + \angle FDC$$

Subtracting,

$$\angle EFH - \angle DFH = \angle FEC - \angle FDC$$

Now

$$\angle EFH = \tfrac{1}{2}\angle EFD + \tfrac{1}{2}(\angle FED - \angle FDE) = \tfrac{1}{2}\angle EFD + \tfrac{1}{2}\angle FED - \tfrac{1}{2}\angle FDE$$

Combining and substituting,

$$\angle EFH = 90^\circ - \angle FDE$$

The author states that "the angle ECH or DCH is one-half the intersection angle." This would mean that the angle DCE is the intersection angle. The writer believes that the supplement of this angle is usually spoken of as the intersection angle.

The writer also wishes to point out what is probably a typographical error in the first sentence of the last paragraph. Instead of being a single sentence, this undoubtedly should be two sentences reading as follows:

"In many instances it will prove more accurate and satisfactory to triangulate for the external distances from a right-angle line of a convenient length extending from any suitable point on the external than it will to measure this distance with a tape. The distance would have to be measured accurately."

A. G. HUSTED,
Engineer, Department of Public Sanitation.
Indianapolis.

Sir—The article by C. E. Newell in your issue of Jan. 24 describing a method for rerunning track centers on curves for which there are no notes, and with the point of intersection inaccessible, prompts the writer to make the following comments:

In regard to Mr. Newell's method for the problem in question, I believe it to be open to some criticism. First, it requires the finding of two intersections—a rather slow operation in the field. Second, there is no assurance that the point F will fall in a favorable or even possible location. If not, the position of point E or D must be changed and F reëstablished.

The following method has been used frequently by the writer with good results, both field operations and computations being simple and easily handled by the average instrumentman: Set the points D and E, measure angles at D and E, and the distance DE (Fig. 1). Calculate the sides DC and EC, and solve the triangle DCH for the distances HC and DH and angle at H. As a check HE and HC can be obtained from the triangle ECH. Locate the points H and M, measure the distance HM, which added to HC gives the external CM. The points of curvature can be located by measuring from D and E. If D and E are established on the roadbed the line DE can be measured with a high degree of accuracy, as it will be practically level and free of obstruc-

tions. The point M will usually fall so near the center line of the track that the distance HM can be measured with sufficient accuracy without the use of the intrument at the point H. The results obtained with this method as a rule "check out" better than if the tangents are run to an intersection, when this is possible, as the conditions for accurate chaining along the lines DC, HC and EC are unfavorable.

In the case of long curves it is usually preferable to connect the tangents with a traverse line of two or more chords, as shown in Fig. 2, and, for reasons of accuracy, keep the traverse on the roadbed. The distances DC, CG, HC and HM can readily be calculated, M located, and HM measured. With these data proceed as in the previous problem. A convenient solution for the distances required is by the use of latitudes and departures. The figure CDEFG can be considered a field

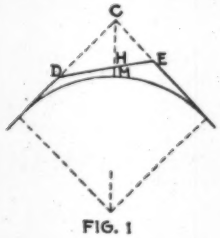


FIG. 1

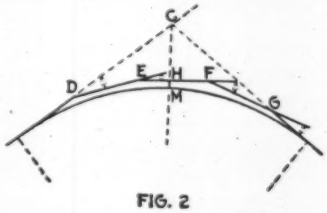


FIG. 2

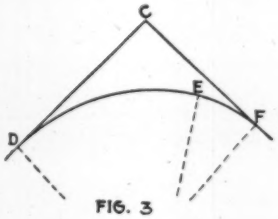


FIG. 3

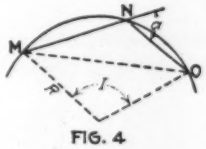


FIG. 4

with all bearings known and two lengths, CD and CG, unknown. Similarly solve CDEHC, with HC and EH unknown.

Locating the points of curve by measuring along the center line of the track from the middle of the curve M is preferred to chaining along the tangents CD and CG. However, it has no advantage over locating them from the points D and G, when they are placed on the roadbed (Fig. 2).

The method of determining the curvature from the external distance is not applicable in the case of compound curves for which there are no notes. The writer has used the following method for this problem (Fig. 3). Determine the degree of each part of the compound curve by the following method: Choose three points in the center of the track, M, N and O (Fig. 4), as far apart as practicable. Measure MN, NO and angle a, and solve triangle MNO for MO. Then $I = 2a$, and $R = \text{MO}/2 \sin \frac{1}{2}I = \text{MO}/2 \sin a$. The curve of the longer part can then be run in to a point where it begins to depart from the center line of the track. This point can then be chosen tentatively as the point of compound curvature (E), and the following part of the compound curve run in, the degree as determined being used. Of course this second part will usually not fit the present alignment, in which case the P. C. C. may be adjusted until it does. The solution of the latter problem is covered in the railroad field books. The fact that the curve, as thus located, when produced will not become tangent at the ends, D and F, is of little moment, as spirals are usually used which, because of their flexibility, will permit any discrepancy at those points (usually small) to be taken care of.

A similar "cut and try" process can often be used to advantage with simple curves.

In conclusion the writer would list the results to be accomplished on curve realignment work as follows:

1. Obtain an alignment that will equalize the throw and cause the minimum amount of track work. Much care, time and thought can profitably be spent to this end.

2. The curvature should not be made more complicated; that is, no changes in curvature should be introduced additional to those in the original location.

3. Curves should be monumented and referenced, and complete notes kept and filed, so as to permit their being readily relocated.

A party consisting of an instrumentman and two chainmen, one of whom is capable of assisting in computation, is ample for this work. Some railroad engineers make the mistake of delegating work of this nature to young transitmen with no special training along this line. This often results either in "fudging," or, worse still, needless expense of track work. The problem is quite different from that of curvature on location. It should be entrusted only to men experienced in this work, who have served their apprenticeships as chainmen and are ingenious, good computers and familiar with the track work involved.

G. F. SCHLESINGER.
Assistant Professor of Civil Engineering, Ohio State University.
Columbus.

[Several other letters have been received commenting on Mr. Newell's article, but the four published seem to cover the main points.—Editor.]

Two Suggestions for Municipal War Programs

Sir—In your issue of Jan. 10, 1918, you ask for suggestions for a municipal war program "designed to help win the war for democracy with the least possible sacrifice and increased burden on the part of the municipal citizenship."

The very fact that you ask this question implies that answers to it have long failed to be forthcoming. I beg leave to suggest that the reason why such answers have not come to the front is very largely due to the fact that we have not been ready to sacrifice the preconceived notions which stand between us and the solution of the problem.

Possibly under the influences of war, and very much as you suggest in your admirable opening editorial of Feb. 7, it may be that these notions need no longer stand in the way. If that is true then we ought not to be long in ceasing to run city finances on the assumption that the person who builds or improves his own property is the one who must also bear a correspondingly increasing share of the city's expenses. In short, although we must all be well aware that the only form of property which is enhanced in value by public im-

provements is land, we have been remorselessly taxing other forms of property than land in order to finance these improvements. Another way of saying the same thing is that we have been penalizing energy and usefulness in order to subsidize one of the worst evils that can beset a municipality, namely, land speculation.

By correcting this fault we can have an amply productive, smooth-working and invigorating system of revenue instead of a destructive, repressive and demoralizing system of taxes. With municipal revenue obtained from the correct source, the financing of engineering problems which you mention in your editorial will be simple enough. The only interest to be sacrificed is one which is not only unessential but harmful.

With the problem of municipal revenue equitably worked out (as in my opinion can readily be done) and with a form of city government embodying both efficiency and democracy such as is suggested by the Ashtabula (Ohio) form of organization, an excellent beginning would be made in the solution of your conundrum.

LEWIS JEROME JOHNSON,
Professor of Civil Engineering, Massachusetts Institute of Technology.
Cambridge, Mass.

[The editorial had to do chiefly with the planning of municipal undertakings and expenditures with a view to conserving labor, material and capital during the war. Doubtless the single tax and proportional representation will come in for a share of attention in connection with other earnestly urged reforms.—Editor.]

Variations in Transit Needles

Sir—Letters in recent numbers of *Engineering News-Record*, starting with that of W. Newbrough in the issue of Dec. 13, 1917, p. 1119, suggest the desirability of calling attention through its columns to the work which has been done by the United States Coast and Geodetic Survey in the field of terrestrial magnetism, especially with reference to the compass variation or magnetic declination.

Magnetic observations have been made at nearly every county seat in the United States which include the determination of the magnetic declination by a magnetometer free from index error and the true bearings of a number of prominent objects. In many places meridian lines have been established and in most cases the observing station has been marked in a permanent manner. By means of observations at a sufficient number of "repeat" stations, a knowledge has been obtained of the change of declination from year to year.

By applying to this bureau a surveyor can usually obtain the description of a magnetic station in his immediate neighborhood, including the true bearings of a number of prominent objects. With the aid of these he can determine the variation of his compass. By comparing this result with the value derived from the magnetometer observations he can obtain the error of his compass.

It should be borne in mind not only that different compasses will give different results at the same place, but also that the same compass will give different results at different places and different results at the same place at different times.

The change in the course of the day seldom exceeds 20′, and the maximum annual change in the United States is only about 6′. The change from place to place is sometimes quite rapid, as much as 30′ in a few miles, and in these areas of local disturbance little dependence can be placed on compass surveys.

More detailed information on this subject is contained in various publications of the bureau, which can be obtained by applying to the office in Washington.

E. LESTER JONES,
Superintendent, U. S. Coast and Geodetic Survey.
Washington.

Sir—Since writing my communication which appeared in your issue of Dec. 13, p. 1119, I have noted the replies in *Engineering News-Record* and have received several letters from engineers. Some of these treated of the non-coincidence of the geometric and the magnetic axes, and advised me to make various tests to ascertain the cause. While I knew of various reasons, having worked with needles suspended on silk filaments in physical laboratories, still with silk fibers I had never noticed as great a difference in the pointings as was shown by the tests I made, as explained in my letter, so I concluded something was wrong in the manner of suspension of the needles.

I examined the pivots and found they were bluntly sharpened, although the point itself was moderately sharp. I took this pivot and sharpened it to a long taper and brought it to as fine a point as I possibly could, and then tested the needles, and in no case did I find a difference of more than ten minutes, and practically the differences were about five. I then sharpened the other pivots and found the same result.

I was fully aware that an instrument maker could not sharpen his pivots as finely as I did, because if he did so and a surveyor forgot to tighten his needle ven once it would ruin the fineness of the pivot and really make it too dull. An instrument maker could not afford to send out that kind of a pivot on his compasses or transits, or he would be "cussed" by every surveyor who attempted to use his instruments.

Now, how shall we get a sharp point on the pivot that will be of use? I had W. & L. E. Gurley take one of their pivots and break off or grind off the needle. Then I had them cut two slits at right angles, just large enough for an ordinary sewing needle to be slipped into the slit. When the pivot is screwed into the transit plate the hole in the plate acts like a chuck and holds the needle firmly.

When this was returned to me I broke off half a dozen sewing needles, making them a shade longer than necessary, and ground them all down to the same length, laying them alongside of each other and examining them for length with a magnifying glass.

The proper length of the first one was, of course, found by trial. The half dozen I put in a small envelope and placed in the transit box, and now I can have a sharp point at any time by merely inserting a new sewing-needle point, and the change does not take more than two minutes and can be made in the field.

I have tested them out and they work all right. The cost of making this split pivot chuck is nominal.

Kemmerer, Wyo. W. NEWBROUGH.

NEWS OF THE WEEK

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Plans for Financing Railway Needs Announced

Advisory Committee for Raising of Funds and Regional Committees To Direct Purchases

Director General McAdoo has approved the following plan submitted by the director of the Division of Finance and Purchases for the organization of that division, substantially as follows:

"The director of the division will be assisted in the work of investigating and providing plans to meet the financial requirements of the railroads throughout the country, whether these needs relate to the taking up and renewal of maturing obligations and the issuance of new securities, or the providing for betterments and additions, by an advisory committee of three men, experienced in finance, who will be selected, one from the North, one from the West and one from the South. These men, whose names will be announced later, will serve the Government without compensation, and will have offices in Washington. Requirements for new capital, for new equipment, betterments and additions have usually called for from $250,000,000 to $750,000,000 per annum.

ADVISORY COMMITTEE ON PURCHASES

In the matter of purchases for the railroads, which will amount to between $1,000,000,000 and $2,000,000,000 per annum, the director of the division will be assisted by an advisory committee of three which will be composed of the general purchasing agents or vice-presidents in charge of purchases of three leading railroad systems, who will be detailed to Washington for this work, under the supervision of the director of the division.

There will also be constituted three additional committees, these committees to be composed of three or more general purchasing agents, or men experienced in this work, to be known as the regional purchasing committees, with headquarters in New York, Chicago and Atlanta, in touch with the regional directors of these three districts.

All purchases of locomotives, passenger, freight and other cars and steel rails will be made directly through the office of the director of purchases.

In the New England territory fuel purchases will be made by a special committee appointed by the regional director, under the direction of the Washington office. In other sections, each railroad will be expected to handle its requirements, under the immediate direction of the respective regional purchasing committees, either collectively with other companies, or separately, as may be directed by that committee.

Cross-ties and lumber which can be obtained along the lines of the respective roads will be negotiated for through the purchasing department of each road, under the supervision of the regional purchasing committees. Cross-ties needed by the various roads which cannot be obtained on their own lines will be purchased through the Washington office.

All other supplies needed for current operations will be bought, for the time being, through the purchasing departments of the respective roads, but all contracts for periods of six months or longer must be approved by the regional committees before completion.

Information as to the prices paid for all supplies will be furnished monthly by all roads to the regional purchasing committees, so that the prices paid by each road for all articles may be carefully compared and checked as to prices, standards, qualities and places of delivery.

Legislation Proposed to Relieve New York Contractors

Serious Situation Arising Since This Country Entered War May Be Adjusted by Paying Actual Cost of Work Completed

In order to cope with the labor and material situation, which has reached a crisis on contracts for public work in New York, the General Contractors' Association has asked the state authorities to prepare and introduce a bill whose enactment would hasten the completion of the most essential and necessary of such contracts, make it possible to suspend those of less immediate necessity, and relieve the contractors of a financial burden resulting from extraordinary conditions which could not have been anticipated at the time these contracts were taken.

According to members of the association, contracts for public work have been slowed down materially during the past year through the loss of labor resulting from the activities of the U. S. Government since its entry into the war with Germany. A large number of road contracts have been suspended for some time, and in addition the work both on barge canals and on New York subways has been gradually slowing down, due to the inadequate supply of labor and material. With this slowing down has come an increase of cost, due to the delay in the work as well as to the increased price of labor, together with the decrease in its efficiency.

The prospective activities of the U. S. Government at the port of New York, as indicated by inquiries for materials and labor, are said to indicate that the labor required on this Government work during the coming summer will exceed that now employed on subway construction. It is feared that without the assistance afforded by the proposed legislation there will shortly be a forced practical suspension of work on subway and other public contracts for an indefinite period.

The proposed legislation consists essentially of the following provisions: Upon the initiative of the public authorities and the filing by the contractor on public work of a stipulation consenting to a cancellation of his contract, the contract is to be cancelled. The cancellation lies in the discretion of the public authorities of the particular department with which the contract has been made, and such discretion is to be exercised only where the public interest will be served and there is reasonable ground for the belief that the contractor has sustained material losses as a result of the state of war. On cancellation and as a consideration therefor there is required of the contractor a waiver of claims for damages for any or all causes from Apr. 6, 1917, the date of the declaration of war, and an agreement by the contractor to complete the contract or any part thereof, if so desired by public authorities, for the actual necessary cost without profit from Apr. 6, 1917, to the date of the cancellation. On the other hand, if the authorities so desire, the contract may be cancelled and the work stopped, suspended or completed by forces employed by the public authorities.

In the event of cancellation and payment of actual cost from Apr. 6, 1917, the contractor would receive his contract prices for work done prior to that date, and would reserve claims for damages if any existed prior to that date.

A further advantage would be derived from the proposed legislation by the elimination of the competition for labor by contractors, and from the situation now forced upon the contractor who must keep up work under his contract and to do so must bid against and compete with the United States, paying high wages and high prices for the available supply of labor and materials.

Huge Concrete Government Warehouses To Be Built at Chicago

Extensive warehouse construction at Chicago has been undertaken by the Government to provide facilities made necessary by the rapid expansion of the quartermaster's depot as a center for the purchase, storage and distribution of military supplies. Numerous buildings have been leased and four temporary warehouses built, each 1325 x 96 ft., until the present facilities have now a total floor space of almost 1,580,500 sq.ft. To replace these temporary facilities a six-story reinforced-concrete warehouse is being built for permanent quarters, which will have 1,620,000 sq.ft. of floor space. It is divided into three units 276 x 324 ft., two of which are already under construction. Four railway tracks on the first floor of each unit will be flanked by wide platforms served by ten electric high-speed freight elevators.

The warehouse is situated on the property of the Central Manufacturing District, and was designed by S. Scott Joy, architect for this corporation. The general design is similar to that of the warehouse and freight station described in *Engineering News-Record* of Feb. 28, 1918, p. 405. Tunnels connecting with the district's central power station will carry pipes and conduits for steam, water and electricity and for the sprinkler service.

Revised Constitution Voted Down

By a vote of 1555 to 546 the proposed revised constitution of the American Society of Civil Engineers was defeated. The vote was canvassed and the result was announced March 6 at the regular meeting of the society in New York.

Government Wants Draftsmen

The U. S. Civil Service Commission announces open competitive examinations for appointment to the positions of architectural, mechanical and structural steel draftsmen, for ship work. The examinations are of the non-assembled type. Full information and application blanks may be obtained from the commission, Washington, D. C., or the civil service district secretary in Boston, New York, Philadelphia, Atlanta, Cincinnati, Chicago, St. Paul, St. Louis, New Orleans, Seattle or San Francisco.

Cost-Plus-Fee Bids on Viaduct Received by Kansas City

Nine bids, all on the cost-plus-fee basis, were received by Kansas City on the construction of the Twenty-third Street Trafficway. Both unit-price and cost-plus-fee bids were asked, but no unit-price tenders were submitted. The estimated costs stated by the bidders range from $700,000 to $910,000; the lowest figure was submitted by the Geo. A. Fuller Construction Company.

The call for bids limited the contractor's profit fee—to be named in his bid—to a maximum of 10%. The cost was carefully defined to exclude overhead and superintendence but include the expense of the field office. Any difference between actual and estimated cost will be shared equally by city and contractor, except that the contractor's share of payment for excess cost is limited to two-thirds of his specified fee. His gain from reduced cost is not limited. The bidders included the Geo. A. Fuller Construction Co., Collins Bros., Carmichael-Cryder Co., Geo. A. Siedhoff Construction Co., Dock Contractor Co., Hunkin-Conkey Construction Co., Arkansas Bridge Co., Concrete Construction Co. and Missouri Valley Bridge & Iron Company.

The contract was discussed in *Engineering News-Record* of Mar. 7, p. 471.

Hundred and Forty Millions for Engineer Equipment

Largest Sums for Troops in France—$18,000,000 More for Hospital Construction

In a hearing on the urgent deficiency bill before a committee of Congress the War Department outlined the program for additional construction needed at the cantonments and other army stations in this country. The Engineer Corps reported a deficiency of $140,000,000.

According to Brigadier General Littell, $20,500,000 will be required to complete the cantonments and National Guard camps. Painting and finishing the camp buildings is estimated at $2,000,000. Another big item was motor repair shops, which will reach a cost of $5,700,000. These are now under construction. Additional water-supply and iron-removal plants for the cantonments and camps will involve an expenditure of $600,000. Camps Dodge, Funston and Sherman are mentioned among those where new water-supply installations will be made.

Lining the buildings at regular army camps will cost $1,000,000. Additional rifle ranges are planned at a cost of $600,000. Three quartermaster machine repair shop units at Camp Ordway will cost $800,000. Shelter for heavy ordnance is estimated at $3,800,000; shelter for additional animals, $1,800,000; heating garages, $3,000,000; shops and machine tools, $3,200,000.

Another big expenditure contemplated is $18,000,000 for the construction and repair of hospitals. Some of the principal items under this head are: Additional two-story ward barrack buildings for National Army base hospitals, 10 or 12 of which will be built at each cantonment, except Camp Funston, at a total cost of $5,340,000; similar buildings for National Guard base hospitals, to cost $3,450,000; steam heat for National Guard base hospitals at $107,000 each; six convalescent camps to cost $1,200,000; construction at 10 established army posts, to convert them into hospitals, $1,500,000; additional buildings at various hotels which were leased for army hospitals, $1,000,000. Other lesser items cover painting, the construction of laundries and various additions to existing hospitals at the camps and cantonments.

Major General Black stated that a deficiency appropriation of $140,000,000 was needed to cover the requirements of the engineer corps up to June 30. These estimated expenditures, which are partly covered by existing appropriations, are as follows:

Director General of Military Railways:	
Additional rolling stock	$18,500,000
Additional locomotives	2,500,000
Additional shop equipment	2,000,000
Additional track materials	8,000,000
Floating plant	300,000
Anticipated requirements for seven months	35,000,000
	$66,300,000
General engineer depot:	
Requisition Nos. 1-11	110,000,000
Miscellaneous engineer material and supplies	28,000,000
Estimated expenditures in Europe:	
Based on cablegram from General Taylor	50,000,000
By other officers	700,000
Total	$255,000,000

Rivers and Harbors Bill Smallest in Years

The rivers and harbors bill for the current year carries a smaller appropriation than any similar bill in the recent past. The total is $19,227,000. Only one new project is included and no provision is made for surveys. Among the large items are $5,000,000 for continuing work on the Ohio River, $2,200,000 for continuing work in the East River at New York, and $1,700,000 for the Southwest Pass at the mouth of the Mississippi.

Contractors for Work at Port Newark

In *Engineering News-Record* of Feb. 28, p. 431, and also in the issue of Jan. 31, p. 233, a record of the contracts for the cantonment division of the Quartermaster Corps, with the names of the contractors, was published. The contractor mentioned for contract No. 1 at Port Newark, N. J., was MacArthur Bros. This contract was originally awarded by the Government to MacArthur Bros., but it was reassigned to Mason & Hanger-MacArthur Bros., Inc., on Jan. 26. This work is being carried on under the management of the Mason & Hanger organization.

Progress on Detroit's Big Sewer Program

Last fall contractors were wary about offering to build large trunk sewers for Detroit, but during the winter bids reasonably near and in one or two cases below the engineer's estimates were received, and several contracts were awarded. On Mar. 1 a number of bids were received on the proposed Lonyo Road reinforced-concrete sewer job, consisting of 8318 ft. of double-barrelled sewer, each barrel

4 x 14½ ft. in cross-section. The lowest bidder was Worswick Bros., a local firm heretofore engaged in schoolhouse construction. The acceptance of its bid of $1,122,754 has been recommended.

The work was advertised in two sections of nearly equal length. The total of the lowest bids for the two sections, separately, was $1,413,000 and the total of the highest bids was $2,186,000. Bids on other large contracts will follow. Clarence W. Hubbell is city engineer and William H. Fenkell is commissioner of public works of Detroit.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN RAILWAY ENGINEERING ASSOCIATION; 910 Michigan Ave., Chicago; Mar. 19-21, Chicago.

AMERICAN WATER-WORKS ASSOCIATION; 47 State St., Troy, N. Y.; May 13-18, St. Louis, Mo.

The regular meeting of **The Louisiana Engineering** Society, held in New Orleans Mar. 11, had for its principal feature the reading of a paper on "The New Orleans Industrial Canal," by A. M. Lockett.

At a joint meeting of **The Colorado Association of Members of the American Society of Civil Engineers** and the Colorado Scientific Society, Mar. 9, H. E. Hilts, general manager Portland Cement Association, spoke on "The Construction and Use of Concrete Ships."

The Highway Engineers' Association of Missouri held its business meeting at Kansas City, Mar. 1, and elected officers as follows: President, M. S. Murray, Sikeston; vice president, John McK. Southgate, Rolla; secretary, J. P. Davis, Jefferson City.

Under the auspices of the **Lewis Institute Branch, Western Society of Engineers, Chicago,** a series of free lectures on aviation is being given at the Lewis Auditorium. The subject of the fifth lecture, delivered by Frank Harrison Wade, on Feb. 28, was "Instruments and Bombing."

The Feb. 25 meeting of the **Engineers' Association of Nashville, Tenn.,** was devoted to a discussion of the referendum of the Chamber of Commerce of the United States on the legislation for the development of the water power of the country. Prof. W. H. Schuerman, of Vanderbilt University, was the principal speaker.

The Engineers' Club of San Francisco on Feb. 28 tendered a farewell luncheon to W. W. Briggs, who left San Francisco, Mar. 1, to become manager of the New York division of the Westinghouse Lamp Co. Mr. Briggs is one of the charter members of the club and a past president. He has been general agent of the Great Western Power Co. at San Francisco since 1913.

On Mar. 19 **The Cleveland Engineering Society** will listen to the reading of an illustrated paper on "A Scientific Aspect of Modern Warfare," by M. Luckiesh, of the National Lamp Works of the General Electric Co., Cleveland.

PERSONAL NOTES

B. J. FINCH, connected with the office of Public Roads and Engineering, has been transferred from North Portland, Ore., to San Francisco, to take the place of C. H. Sweetser, who has been commissioned captain in the U. S. Army.

EDWARD V. MAITLAND has been appointed supervising engineer for the Quartermaster's Department, Construction Division, on the proposed U. S. Ordnance Storage depot near Harrisburg, Pa. Mr. Mailtland was formerly division engineer of the Pennsylvania R.R., and of the New York, Westchester and Boston R.R., and during recent years has been consulting engineer in New York City.

EDWARD U. SMITH has been promoted from the position of chief draftsman of the Philadelphia branch of the Austin Co. to that of district engineer. Mr. Smith has been connected with the Austin Co. since 1915.

A. F. MELLEN, who was until recently chemist in charge of the filtration plant of the City Water Co., Chattanooga, Tenn., has become city chemist in charge of the filtration plant for Moline, Ill. The city is rehabilitating the plant.

MAURICE F. BROWN, who has been supervising the structural steel work at the Squantum, Providence and Buffalo "Victory Plants" for the Aberthaw Construction Co., has resigned to become connected with the production division of the United States Shipping Board at Washington.

H. A. STRINGFELLOW, formerly assistant engineer with Wynkoop Kirsted, consulting engineer, Kansas City, has accepted the position of first assistant engineer to R. Winthrop Pratt, consulting engineer, Cleveland, on the filtration investigations at Detroit.

FIRST LIEUT. ELWOOD AVERY, Engineer Reserve Corps, has been assigned to the Quartermaster's Corps as assistant to Maj. William B. Gray, construction quartermaster of the U. S. Ordnance depot near Harrisburg.

PROF. R. J. FOGG has a leave of absence from Lehigh University, and is acting as resident engineer at the "Victory Plant," Squantum, Mass., for Monks & Johnson, architects and engineers.

A. P. FERRILL, until recently of New Haven, Conn., is now assistant engineer with the Central Romano, a sugar company at La Romano, Santo Domingo.

C. G. JONES has been appointed captain in the 31st Railway Engineers. He was employed for some time in engineering work during the construction of the Panama Canal, later going to Alaska, where he was superintendent of construction on the government's railway.

W. H. EYER has been appointed engineer and roadmaster of the Bloomsburg & Sullivan R.R., to take the place made vacant by the death of W. C. Fortune.

T. FRANK QUILTY, member of the contracting firm of John J. O'Heron & Co., and vice-president and treasurer of the Superior Stone Co., Chicago, has received a major's commission in the Engineer Officers' Reserve Corps. He reports to the officer in charge of cantonment construction.

HENRY R. PUTNAM, New York City, has been commissioned as captain in the Engineer Officers' Reserve Corps.

W. E. BROWN, civil and landscape engineer, has opened an office at Miami Beach, Fla., for the practice of civil and landscape engineering.

W. C. PEMBROKE, formerly assistant engineer maintenance of way, Coal & Coke Ry., at Elkins, W. Va., has been promoted to engineer maintenance of way, vice W. C. Hawkins, resigned.

PROF. M. C. BEEBE, of the College of Engineering of the University of Wisconsin, has been granted leave of absence to enter war service. He will work on Government war problems with the Western Electric Co., New York.

C. S. LOPER, professor of engineering of Washburn College, Topeka, Kan., has been appointed captain in the sanitary division, National Army, and has reported at Fort Oglethorpe, Ga. Captain Loper was graduated from the University of Kansas in 1910 as a civil engineer, and later received the degree of master of science in sanitary engineering from Harvard University. His place as professor of engineering at Washburn College will be filled by R. E. Scammel, a graduate of the University of Kansas, who has been structural designer for the Capital Iron Works of Topeka for the last seven years.

M. C. BLANCHARD, district engineer of the eastern district of the Atchison, Topeka & Santa Fe Ry., has been appointed acting superintendent of the middle division, succeding R. H. Allison, who goes to the Illinois division,

succeeding G. E. Ayer, resigned. Mr. Blanchard's headquarters will be at Marceline, Kan. W. H. Guild, division engineer of the Illinois division, has gone to Topeka to succeed Mr. Blanchard.

EMIL PRAEGER, assistant civil engineer, U. S. N., until recently in Brooklyn, N. Y., is now at San Diego, Calif.

G. S. LEAVENWORTH, chief engineer of the No. 20 Copper Mining Co., Copper Hill, Tenn., has been elected secretary and treasurer of the Appalachian Iron & Mining Co., Murphy, N. C. He will retain his position with the No. 20 Copper Mining Co.

G. E. MIERS, until recently with the Boston & Maine R.R. at Boston, is now with Stone & Webster at Dover, New Jersey.

FRANKLIN R. MCMILLAN, assistant professor of structural engineering, University of Minnesota, has been appointed research engineer, department of concrete ships, Emergency Fleet Corporation, with headquarters at Washington, D. C.

ADOLPH F. MEYER, associate professor of hydraulic engineering, University of Minnesota, has been appointed chief engineer of the Minnesota & Ontario Power Co. and subsidiary companies, with headquarters at International Falls, Minn.

DON W. BINGHAM has succeeded Dr. W. F. Walker as sanitary engineer for the Detroit board of health, Dr. Walker taking up the duties of Dr. Henry F. Vaughan as assistant health officer. Dr. Vaughan is now in the national service. Mr. Bingham was assistant state sanitary engineer for four years.

J. OTIS BURRAGE, of San Francisco, has been appointed engineer in the division of shipyard plants for the Emergency Fleet Corporation, and will be stationed for the present at Washington, D. C.

A. PAUL LOW has been appointed county engineer of Wailuku, Maui, H. T., to succeed Joel B. Cox, resigned. Mr. Low was formerly assistant to Mr. Cox.

C. G. MORRISON, senior engineer of the Ogden, Utah, branch of the Office of Public and Rural Engineering, District No. 2, has been appointed district engineer of the Alaskan Highway Commission, under the U. S. War Department.

C. E. NAGLE, field engineer for the Portland Cement Assn., with headquarters at Minneapolis, has accepted a position with the Emergency Fleet Corporation at New Orleans, as first assistant district engineer. He was formerly bridge engineer for the Minnesota state highway department.

J. S. SIMPSON, engineer in the employ of the State Public Service Commission, Olympia, Wash., has resigned his position and will open offices in Seattle with Henry L. Gray. Mr. Simpson will begin immediately the cost appraisal of the Inland Empire and Washington Water Power Co.'s electric railway properties at Spokane. The two concerns plan to consolidate.

OBITUARY

Col. EDWIN AUGUSTUS STEVENS, head of the Stevens family of Hoboken, N. J., famed for its engineers, died Mar. 8 in Washington, D. C.

Colonel Stevens was born in Philadelphia Mar. 14, 1858, being the second son of Edwin Augustus Stevens, who founded and endowed Stevens Institute of Technology, Hoboken. He was graduated from Princeton in 1879. His best-known contribution to engineering science was his design of the first screw ferryboat, the "Bergen," which still plies the Hudson River. He also worked on designs of high-speed steam engines and mechanical tools. He was consulting engineer for the City of New York in connection with the construction of ferryboats for the municipal ferry to Staten Island, and also had charge of the designs of ferryboats for the Lackawanna R.R.

In 1911 Woodrow Wilson, then Governor of New Jersey, appointed Col. Stevens State Public Road Commissioner. Governor Fielder reappointed him, and Governor Edge made him a member of the State Highway Commission. Soon after the outbreak of hostilities with Germany President Wilson appointed Col. Stevens Government inspector of shipyards.

Colonel Stevens was a life member and vice-president of the American Society of Mechanical Engineers and vice-president of the Society of Naval Architects and Marine Engineers. He was also a member of the American Society of Civil Engineers and the Institute of Naval Architects of Great Britain. He received his military title as commander of the old Second Regiment, National Guard of New Jersey.

JOHN D. VAN BUREN, New York State Engineer from 1876 to 1878, and for many years a consulting engineer of New York City, died Mar. 11 at New Brighton, S. I., in his eightieth year. Mr. Van Buren had been retired for several years. He was born in New York City, and was graduated from Rensselaer Polytechnic Institute in 1860. During the Civil War he saw service on naval vessels in the Potomac River, and at the close of the war was admitted to the bar in New York. Mr. Van Buren practiced law only a short time, and, returning to his original profession of engineering, was appointed by Governor Tilden a member of the commission to investigate frauds in connection with the Erie Canal construction. As a result of his investigations Governor Tilden appointed him State Engineer.

If he had survived until May 20 of this year Mr. Van Buren would have been a member of the American Society of Civil Engineers for fifty years.

CAPT. CHARLES JAMES DU BOIS, civil engineer, died Feb. 12 at Macon, Mo. He was born in Wyoming County, New York, Oct. 1, 1840, and was educated at the Philadelphia Polytechnic College. He enlisted in the Union army in 1861 and served through the Civil War. In 1866 he settled in Missouri and took up railway work. He was connected with many railway projects in the West, and was engineer for a number of small lines which later became parts of larger systems. He was chief engineer and manager of the St. Louis, Keokuk & Northwestern Ry. (Burlington System), in 1882, and of the Litchfield, Carrolton & Western Ry. in Illinois, in 1884. In 1886 he was engineer of location on the Chicago, Rock Island & Pacific Ry., and the town of Du Bois, Neb., was named after him. From 1888 to 1891 he was engineer and promoter for several lines in Oklahoma; he also located town sites and was the founder and first mayor of the town of Reno, Okla. In 1892 he was chief engineer for John I. Blair's railway interests and of the St. Louis & Hannibal Ry. From 1894 to 1897 he was engaged on special location work for the Missouri Pacific, the Santa Fé, and the Denver & Rio Grande railways. In 1897 he was chief engineer of the St. Louis, Iowa & Nebraska Ry., and as late as 1909 he held the same position for the projected South Dakota International Ry. He was engineer and promoter also of several coal lines. Among other activities he had charge of paving and sewer work in several Missouri towns, including Macon, Mexico, Brookfield, Trenton and Kirksville. Since 1909 he had done consulting work only. He was married in 1869, and is survived by his widow and three sons. One of these is Capt. Charles R. Du Bois, Engineers Reserve Corps, assistant construction quartermaster at Camp Funston, Kansas.

W. S. DANES, aged 65, retired engineer maintenance of way of the Peru division of the Wabash Ry., died Feb. 22 in Chicago. He became connected with the Wabash in 1880, as general foreman in charge of bridges and buildings. Later he became superintendent of bridges and buildings and engineer maintenance of way.

JOHN BRODERICK, contractor, Nashville, Tenn., died Mar. 2. He did much work for the city in building sewers, bridges, constructing concrete and foundation work, and in grading streets. All the sewerage work done for Camp Andrew Jackson last year was the work of Mr. Broderick. He was born in Queenstown, Ireland, in 1844.

NEWS OF ENGINEERING INDUSTRIES

FOR MANUFACTURERS WHO SERVE ENGINEERS AND CONTRACTORS

Railroads Increase Use of Machinery to Conserve Labor Supply

What Is Being Accomplished in Yard and Shop and on Maintenance of Way with Industrial and Engineering Equipment

No industry has been hit harder by the labor shortage than the railroads. They were unable to meet the wage raises that the manufacturing field offered to both skilled and unskilled labor.

Fortunately, our railroad army has a singular "pride in calling." The railroad man likes his work as a rule—the railroad civil engineer, the operating official, the trainman, the engineman, the dispatcher, the trackman, all take pride in their skill, and there is a zest to railroading that holds them to "the old pike." It takes something more than money to pry these men loose from railroad work.

But, though most of the officials and a good percentage of skilled railroad men have stuck to their posts, there has been a severe shortage of machinists, boilermakers and car shop workers, freight house crews, track labor and bridge and building labor.

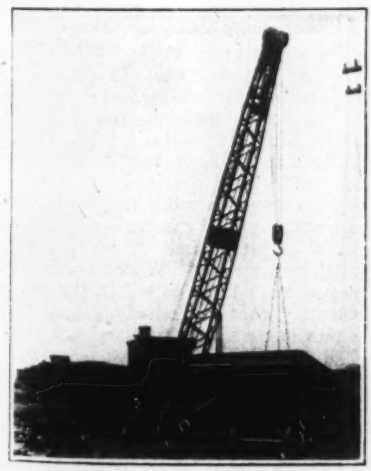
In consequence the officials responsible for maintenance of way and structures, for car repairs, motive power and freight handling, have been utilizing all kinds of labor-saving equipment to a greater extent during the past two years.

It is interesting to note the manner in which standard construction equipment and industrial plant equipment are being adopted for maintenance and yard work by the railroads.

Crane Cuts 16 Men from Car Gang

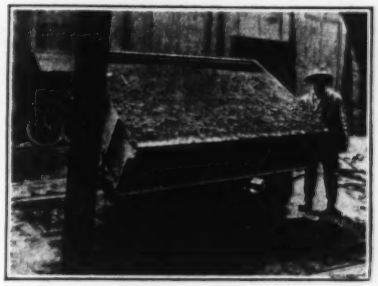
With the increasing shortage of labor in every department of the railroads new uses are found for the locomotive crane. Perhaps this explains the strength of the demand for locomotive cranes in the railroad field even before this country entered the war.

The Brown Hoisting Machinery Co., Cleveland, Ohio, recently found one of its cranes working on car assembling in a railroad yard. The crane was unloading 17,000-lb. car frames from a flat car and placing them on the trucks at the rate of ten an hour. Fourteen workmen were used in the gang. The railroad stated that it formerly took a gang of 30 men to assemble 8 frames an hour.



ASSEMBLING 10 CARS AN HOUR

Storage Battery Trucks Invade the Roundhouse and Shop



Storage battery industrial trucks, in which railroads were first interested as baggage-handling equipment for passenger stations, have lately invaded the freight terminals, shops and roundhouses.

Some are equipped with small electric cranes and hoists for handling barrels, scrap iron and boiler plate. Others are built with detachable side-dump or end-dump bodies, ranging in capacity from 20 to 80 cu.ft., for hauling coal, ashes, sand or gravel. The cost of operation, excluding the operator's wages, varies from 50c. to $1.50 for a 10-hr. day. The illustration and data were furnished by C. W. Hunt, Inc., West New Brighton, N. Y., who manufacture different types of this equipment.

Gang of "Jerries" Race Against Pneumatic Tie Tampers

In a competitive 8-hour test between hand tamping and machine tamping on one of the big railroads the following results were obtained:

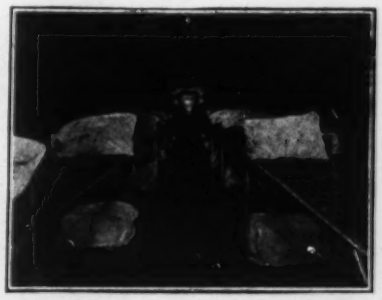
	No. of Men	Ft. of Track Tamped	Total Cost
Hand gang	16	500	$43.50
Machine gang	6	528	25.45
Saving	10	...	$18.05

The railroad calculated that at this rate it was saving $3610 in a tamping season of 200 days.

The machine gang was equipped with a four-tamper gasoline outfit, with compressor carried on the section car as illustrated. Illustration and data were furnished by the Ingersoll-Rand Co. of New York, manufacturers of the "Imperial" pneumatic tie tamper.

A Modern Car Camp for Maintenance Gangs

In the old method of housing extra gangs and even carpenter gangs, bridge gangs and other skilled workers, the "bad-order" box car was good enough. High wages in the industries have drawn men from the railroad field to such an extent that today the housing and bunking facilities are receiving greater consideration.



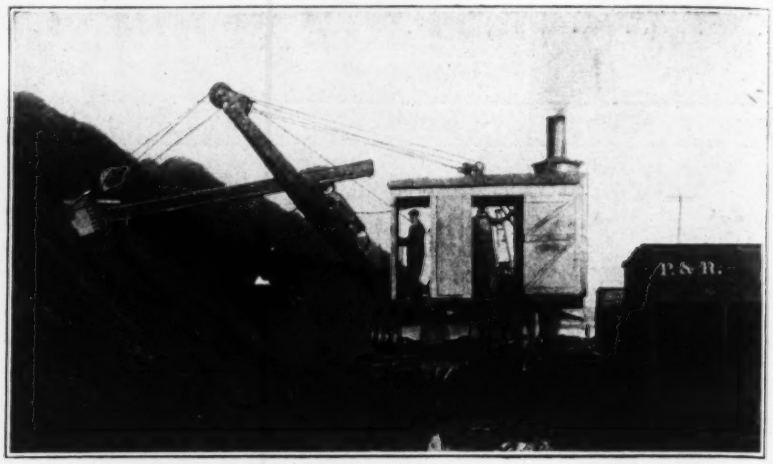
The illustration shows the way in which one road bunks an M.W. extra gang, using old passenger coaches and double-deck steel beds. The Southern-Rome Co. of Baltimore, Md., is the maker of this equipment.

Revolving Steam Shovel Wins Its Place as Railroad Ditcher

Labor shortage on maintenance of way was becoming acute two years ago when the Pennsylvania Railroad Co. first tested the possibilities of the revolving steam shovel as a railroad ditcher. This spring the company owns six Erie Ditchers. The Burlington also purchased two of them last week.

The Ball Engine Co., whose equipment (the Erie Ditcher) is illustrated, developed this use of the revolving steam shovel. The shovel is fitted with triple-flanged wheels to permit travel on overlapping rails across the aprons between cars. It may thus run the entire length of a train of flat cars, loading as it goes, or swing the spoil to cars standing on adjacent tracks.

The Pennsylvania Railroad ordered one of their recent ditchers equipped with a structural steel boom and ¾-yd. clamshell bucket. While this was intended for the engineering department to use on construction work, the motive power department commandeered it in an emergency for coaling locomotives. Engines were coaled in from 6 to 10 minutes, each locomotive calling for 18,000 to 19,000 lb. of coal. The ditcher was then moved down to the cinder dump pit and loaded 100,000-lb.-capacity cars in 35 minutes each.



DITCHER RUNS THE ENTIRE LENGTH OF FLAT CAR TRAIN

Railroad Furnishes Concrete Contractors with Steel Forms

In order to obtain uniformity in the finish of a large number of concrete bridges within the City of Chicago, the Illinois Central R.R. purchased all concrete forms used on the work and furnished them to the contractors.

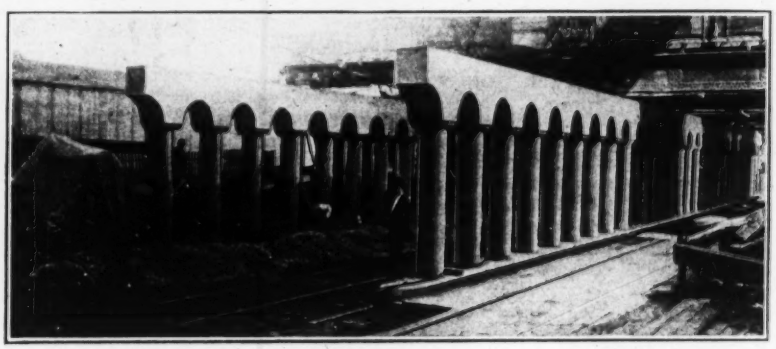
In 1915 the John J. O'Heron Co., contractors, built six bridges with these special forms, each bridge containing three rows of columns and cross girders. Forms were furnished for two complete rows each 114 ft. wide. The columns are on 6-ft. centers.

In 1916 Bates & Rogers, contractors, built two bridges with the same forms, and in 1917 the Gould Construction Co. built four bridges with them.

The forms have been kept coated with light form oil, and although they have been used about 20 times are in first-class condition. It is estimated that each set will be used 30 times before the end of the job.

This work is under the direction of the Bridge Department of the Illinois Central R.R., C. C. Westfall, bridge engineer. The steel forms are "Blaw-forms," built by the Blaw-Knox Co., Pittsburgh.

All of the structures on this job were of the same general type shown in the illustration below.



BY FURNISHING ALL BRIDGE FORMS RAILROAD GETS UNIFORM WORK

GETTING FULL SERVICE OUT OF A WORK TRAIN

Where Frequent Trains Interrupt Ditching Operations

The Mobile and Ohio R.R. discovered that by coupling a single ditching machine between two air-dump cars instead of its usual method of loading to flats, it was able to do 25% more work for 44% less money. By the same method the Georgia, Florida & Alabama Ry. kept the cost of ditching down to nearly 14c. per cubic yard.

By the use of two ditching units, the cost per cubic yard can be even further reduced and the time of the job appreciably shortened. Where traffic requires a work train to get in the clear frequently, this method of working the ditchers is particularly effective.

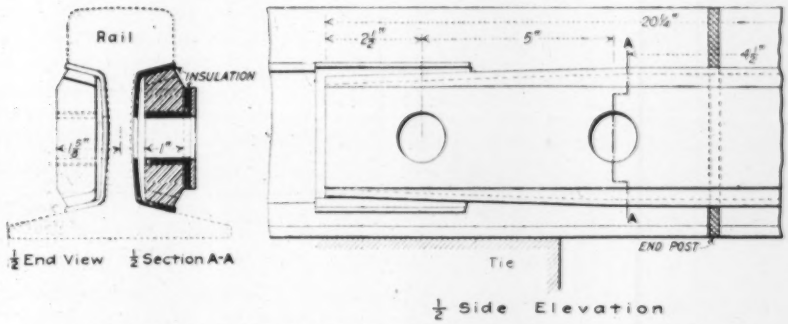
The figures for the above note were furnished by the Western Wheeled Scraper Co., Aurora, Ill., manufacturers of Western air-dump cars; and the photograph, which shows a Kansas City Southern job, is by the American Hoist & Derrick Co., whose American ditchers are shown.

New Insulated Joint Provides for Wave Motion in Rails

Contact between the splice bars and the head and base of rail in the Roach insulated rail-joint is limited to a length of 2 in. from the end of each rail. Beyond this the bars are reduced in depth and serve mainly to hold the rails in line. This arrangement of contact surfaces is the same as in the uninsulated Roach joint, described in *Engineering News* of March 8, 1917, p. 409. Its purpose is to allow free travel of wave-motion through the joint, with transfer of this motion from rail to rail through the middle portion of the splice bars. That is, deflection of the leaving end of one rail under load causes the bar to deflect the receiving end of the next rail correspondingly.

This feature is considered to relieve the stress and wear on the fiber insulating parts so as to increase their life materially. These parts include channel-shaped plates between the splice bars and rails, ferrules in the bolt holes and an end-post between the abutting rails. Plain flat bars or fishplates are used, 20¼ in. long, with four bolts. At the middle of the joint the bars are clear of the rail web insulation, as shown in the drawing. The outer bolts, however, are tightened to such an extent as to bring the ends of the bars into close contact with the insulation.

An earlier design provided a base support for the rails, but the joint as now made, and shown in the accompanying drawing, is simpler and cheaper. Several railways have made trial of this device. It is the invention of H. F. Roach, president of the Reinforced Rail Joint Co., St. Louis.



THIS JOINT IS DESIGNED TO TRANSMIT RAIL DEFLECTION

Standard Motor Truck Cost System Adopted

One hundred and fifty truck owners and traffic men from the Middle Western and Atlantic Coast states joined in formulating a national standard motor truck cost system, at the third national Truck Owners' Conference at New York last week. The form as adopted was submitted to the Highways Transport Committee of the Council of National Defense, and is expected to be used by that body in compiling cost data in connection with war work.

The first day's conference, which was a closed session, was addressed by Assistant Postmaster General Blakeslee, who discussed the Government's cost keeping methods in operating the 2200 trucks owned by the U. S. postal service, and the 16,000 trucks operated by the department under contracts. Many of the Government-owned trucks were said to be earning as high as $100 a day. Roy D. Chapin, chairman of the Highways Transport Committee of the Council of National Defense, outlined the latest developments in national motor transport.

The problem of tabulating trailer costs was solved by noting on the truck cost sheet where trailers were used and proposing to keep complete separate cost data on the trailers, treating them as separate units. The cost forms adopted by the conference will be spread broadcast among truck owners and operators.

"Truscon" Is the New Name

The name "Truscon" has become so firmly identified with the Trussed Concrete Steel Co. that the company has decided to adopt the new name of Truscon Steel Co. The name "Truscon" has been lately applied to the entire line of products manufactured by the firm, including all building material and equipment as well as the portable steel houses.

Aside from the simplification in name there has been no change in the company, its organization or management. The plant and general sales offices are at Youngstown, Ohio, and there are representatives in principal cities.

Small Contractors Are Buying Construction Equipment

"Most of our shipments lately to construction jobs have been to small contractors," said John Sinclair, of the Lidgerwood Mfg. Co., a few days ago. "This indicates that the small contractor is getting work, despite the current impression that all the work under way now is heavy construction that the little fellow does not get a look in upon. It indicates, too, that the big construction companies are holding on to their equipment."

Japanese Buy $15,000 Worth of Water-Works Appliances Here

The Japanese Government recently ordered $15,000 worth of equipment, covering a wide variety of water-works appliances, from the Water-Works Equipment Co., of 50 Church St., New York.

Two years ago S. Nishioeda, engineer of the city water-works of Tokio, visited water-works and filtration plants in our Eastern cities. He seemed particularly interested in American methods of tapping water mains without interruption of service.

Then, two years later, came the order for tapping machines, 2-in. to 28-in. diameter, air compressors, pipe cutters and pipe jointers of all sizes; detectors and detectorphones, wireless pipe locators, tapping sleeves and valves and a complete line of all sizes of corporation tapping machines and corporation cocks.

Daylight Saving Bill To Save Huge Coal Tonnage

United States Chamber of Commerce Presents to Congress Estimate of Possible Economy

In a report on the Daylight Saving Bill presented to Congress last week by the United States Chamber of Commerce some interesting figures were compiled on coal economy and the conservation of electric generating equipment.

Advancing the clock one hour between mid-April and late September would result, it is estimated, in a coal saving of 804,000 tons or 5% of the total consumption for lighting purposes. Advancing the clock one hour from Apr. 1 to Nov. 30 is expected to save 1,019,000 tons, or 6.5%. With an hour advance in time throughout the year the saving is estimated at 1,061,000 tons, or 6.6 per cent.

In addition to saving coal it is pointed out that daylight saving will also enable companies to postpone new investments in equipment to carry the peak of the load, which would mean the saving of millions of dollars. This postponement will come at a time when it is of the highest public interest to avoid all new financing that it is possible to put off. The situation of the Commonwealth Edison Co., Chicago, is cited. In 1916 it had a generating capacity of 360,000 kilowatts. At the end of 1917 it had increased this to 452,000 and according to plans made it will, under present conditions, have to raise this to 600,000 kilowatts by the end of 1919.

Holds Good Will of Constructors Despite Oversold Factory

There is one big, broad-minded manufacturer of construction equipment whose factory is practically tied up with Government work. Yet the company and all of its representatives are doing the best they can to meet the needs of their regular customers among the contractors.

When a contractor calls for equipment, this firm may be able to make delivery at once, if Government orders permit, but more likely ten weeks is the best they can do.

Usually the contractor asks, "Can you help me locate some good second-hand equipment?"

And they do it. They keep tabs on the location of used equipment for this very purpose. If the contractor so desires, they buy the used equipment for him and deliver it to his job. They bill him at the cost of the equipment to them and even omit a charge for truckage.

"We do not consider ourselves philanthropists in giving this service to our customers," said a representative of the company. "When we cannot make delivery we hold the good will of our customers. Don't forget that this war is going to end some day, and we expect to be in business then, too."

Imhoff Tank Users Asked for Statistics

The aid of engineers using or designing Imhoff tanks is asked by the Pacific Flush Tank Co., Chicago, which is required by the Federal Trade Commission under the "trading with the enemy" act to report a detailed list of every sedimentation tank, built or contemplated, which is of the two-story or Imhoff type. It is necessary to state the total population tributary to the territory served by the Imhoff tank.

Many Trucks at Brooklyn Show

Forty-two makes of motor trucks, delivery cars and trailers were exhibited at the Brooklyn auto show last week. This exhibit is said to be the only commercial car exhibit to be held this year. A number of heavy hauling units were shown. Among the exhibits were the Autocar, Bethlehem, Dearborn, Little Giant, Old Reliable, Packard, Selden, Service, Signal, Sterling, Studebaker and Overland.

Three Machinery Associations to Hold Convention Together

A triple convention of the National Supply and Machinery Dealers' Assn., the Southern Supply and Machinery Dealers' Assn. and the American Supply and Machinery Manufacturers' Assn., will be held at Cleveland, Ohio, May 15-17. Among the important subjects to come up for action will be government control of fuel, transportation and shipping, of materials, and price fixing. The coöperation of labor in war activities will also be discussed at length.

BUSINESS NOTES

Walter L. Hart, First National Bank Building, Milwaukee, has perfected a system of coal handling and storage in circular concrete tanks. Recently he has completed arrangements with Pawling & Harnischfeger to furnish the overhead double-track trolleys, with the Blaw-Knox Co. to supply the grab buckets, and with R. L. Reisenger, contractor, to handle the construction.

William Waring, who represented the Galion Dynamic Motor Truck Co., in the Philadelphia territory, has joined the Lakewood organization and will continue to serve the trade in connection with factory and warehouse handling problems.

The following appointments have been announced, to take effect Mar. 1, in the Worthington Pump and Machinery Corporation: James E. Sague, vice president, in charge of engineering and manufacturing; Leon P. Feustman, vice president, in charge of general commercial affairs, including contracts, prices, purchases and traffic; Frank H. Jones, vice president, in charge of sales; William Goodman, assistant to vice president; William Schwanhausser, chief engineer; Edward T. Fishwick, general sales manager; Charles E. Wilson, assistant general sales manager. The offices of the above will be at 115 Broadway, New York. Neil C. Lamont has been appointed works manager, Laidlaw works, with an office at the works, Elmwood Place, Cincinnati, Ohio.

At the public sale held by Receiver Guy W. Mallon, at Ironton, Ohio, Feb. 21, the plant, land and other property of the Superior Portland Cement Co. were purchased by Morris L. Stephenson for $360,000. It is understood that the purchaser, with others interested, will at once place the plant in condition for operations.

The Asbestos Protected Metal Co., Pittsburgh, announces the removal of its Boston office to the State Mutual Building. It will be in charge of William H. Cummings.

Samuel Scovil, president of the Cleveland Electric Illuminating Co., has resigned to become chief of the production division of the U. S. Ordnance Department, in the Cleveland district.

The Walter A. Zelnicker Supply Co. of St. Louis announces that G. W. Eichlmeier has joined the machinery department of its organization. Mr. Bichlmeir has been connected with the supply departments of the Missouri Pacific and Kansas City Southern Ry. Cos., and was recently secretary-treasurer of the W. L. Sullivan Machinery Company.

The Pittsburgh Wood Preserving Co., Ohio Wood Preserving Co., Michigan Wood Preserving Co. and Acme Tie Co. have moved their general offices to the Century Building, Pittsburgh.

The R. B. Tyler Co., dealers in metal lath, reinforcing steel and general building supplies, Louisville, Ky., has taken over the Tyler Building Supply Co.

The Permutit Co., manufacturers of water softening and water rectification apparatus, located for several years past at 30 E. 42nd St., New York City, announces its removal to 440 Fourth Ave., New York, where after Mar. 15 the entire top floor will be occupied by its offices.

TRADE PUBLICATIONS

A descriptive pamphlet dealing with the construction of the New York Connecting Railroad has been issued by the Lehigh Portland Cement Co. It gives a concise description of the work and is illustrated by a supplement in three colors showing various stages of the concrete construction.

Three "broadside" folders have just been issued by the Watson Wagon Co., of Canastota, N. Y., to describe Watson Trailers. "Don't Make Your Truck Carry an Overload"; "Cut Your Hauling Costs the New Way"; and "You Can Haul Both Loads in One Trip"; are the titles of this series of bulletins.

Contractors and industrial plant managers will find interesting suggestions in the new bulletin of the Ball Engine Co. on Erie steam shovels. It is entitled "What the Erie Is Doing."

"A New Steel Sash Opener" is clearly described in a folder of that title just issued by the Detroit Steel Products Co. The folder shows how a full 90-deg. opening is attained by the new Fenestra Straight Line Sash Opener.

The Vulcan Engineering Sales Co., 1765 Elston Ave., Chicago, Ill., has issued a new catalog entitled "Riveters," illustrating and describing Hanna type riveters. This shows special machines used in fabricating structural shapes and forms for the shipbuilding program and also includes tables showing capacities, dimensions, weights, etc.

The Blystone batch mixer for concrete, mortar and plaster is described and illustrated in a new catalog issued by the Blystone Manufacturing Co., Cambridge Springs, Penn.